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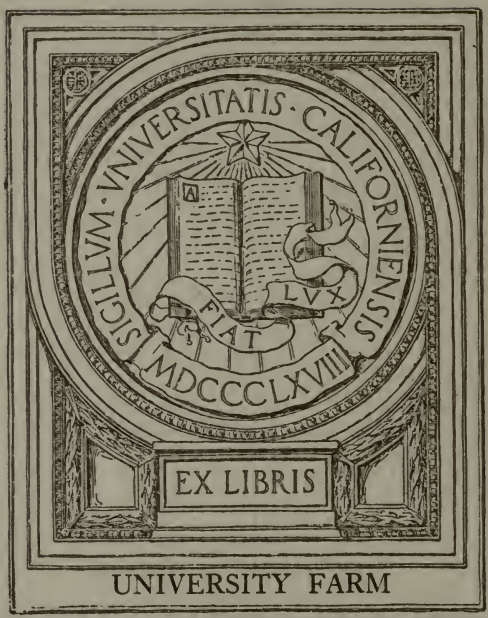
THE WEATHER BUREAU

SERVICE MONOGRAPHS
OF THE
UNITED STATES GOVERNMENT
№ 9

INSTITUTE FOR GOVERNMENT RESEARCH



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THE WEATHER BUREAU

ITS HISTORY, ACTIVITIES AND ORGANIZATION

THE INSTITUTE FOR GOVERNMENT RESEARCH

Washington, D. C.

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OF THE
UNITED STATES GOVERNMENT
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THE WEATHER BUREAU

ITS HISTORY, ACTIVITIES AND ORGANIZATION

BY
GUSTAVUS A. WEBER

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6316

FOREWORD

The first essential to efficient administration of any enterprise is full knowledge of its present make-up and operation. Without full and complete information before them, as to existing organization, personnel, plant, and methods of operation and control, neither legislators nor administrators can properly perform their functions.

The greater the work, the more varied the activities engaged in, and the more complex the organization employed, and more imperative becomes the necessity that this information shall be available—and available in such a form that it can readily be utilized.

Of all undertakings, none in the United States, and few, if any, in the world, approach in magnitude, complexity, and importance that of the national government of the United States. As President Taft expressed it in his message to Congress of January 17, 1912, in referring to the inquiry being made under his direction into the efficiency and economy of the methods of prosecuting public business, the activities of the national government "are almost as varied as those of the entire business world. The operations of the government affect the interest of every person living within the jurisdiction of the United States. Its organization embraces stations and centers of work located in every city and in many local subdivisions of the country. Its gross expenditures amount to billions annually. Including the personnel of the military and naval establishments, more than half a million persons are required to do the work imposed by law upon the executive branch of the government.

"This vast organization has never been studied in detail as one piece of administrative mechanism. Never have the foundations been laid for a thorough consideration of the relations of all its parts. No comprehensive effort has been made to list its multifarious activities or to group them in such a way as to present a clear picture of what the government is doing. Never has a complete description been given of the agencies through which these activities are performed. At

no time has the attempt been made to study all of these activities and agencies with a view to the assignment of each activity to the agency best fitted for its performance, to the avoidance of duplication of plant and work, to the integration of all administrative agencies of the government, so far as may be practicable, into a unified organization for the most effective and economical dispatch of public business."

To lay the basis for such a comprehensive study of the organization and operations of the national government as President Taft outlined, the Institute for Government Research has undertaken the preparation of a series of monographs, of which the present study is one, giving a detailed description of each of the fifty or more distinct services of the government. These studies are being vigorously prosecuted, and it is hoped that all services of the government will be covered in a comparatively brief space of time. Thereafter, revisions of the monographs will be made from time to time as need arises, to the end that they may, as far as practicable, represent current conditions.

These monographs are all prepared according to a uniform plan. They give: first, the history of the establishment and development of the service; second, its functions, described not in general terms, but by detailing its specific activities; third, its organization for the handling of these activities; fourth, the character of its plant; fifth, a compilation of, or reference to, the laws and regulations governing its operations; sixth, financial statements showing its appropriations, expenditures and other data for a period of years; and finally, a full bibliography of the sources of information, official and private, bearing on the service and its operations.

In the preparation of these monographs the Institute has kept steadily in mind the aim to produce documents that will be of direct value and assistance in the administration of public affairs. To executive officials they offer valuable tools of administration. Through them, such officers can, with a minimum of effort, inform themselves regarding the details, not only of their own services, but of others with whose facilities, activities, and methods it is desirable that they should be familiar. Under present conditions services frequently engage in activities in ignorance of the fact that the work projected has already been done, or is in process of execution by other services. Many cases exist where one service could make effective use of the organization, plant or results of other serv-

ices had they knowledge that such facilities were in existence. With the constant shifting of directing personnel that takes place in the administrative branch of the national government, the existence of means by which incoming officials may thus readily secure information regarding their own and other services is a matter of great importance.

To members of Congress the monographs should prove of no less value. At present these officials are called upon to legislate and appropriate money for services concerning whose needs and real problems they can secure but imperfect information. That the possession by each member of a set of monographs, such as is here projected, prepared according to a uniform plan, will be a great aid to intelligent legislation and appropriation of funds can hardly be questioned.

To the public, finally, these monographs will give that knowledge of the organization and operations of their government which must be had if an enlightened public opinion is to be brought to bear upon the conduct of governmental affairs.

These studies are wholly descriptive in character. No attempt is made in them to subject the conditions described to criticism, nor to indicate features in respect to which changes might with advantage be made. Upon administrators themselves falls responsibility for making or proposing changes which will result in the improvement of methods of administration. The primary aim of outside agencies should be to emphasize this responsibility and facilitate its fulfillment.

While the monographs thus make no direct recommendations for improvement, they cannot fail greatly to stimulate efforts in that direction. Prepared as they are according to a uniform plan, and setting forth as they do the activities, plant, organization, personnel and laws governing the several services of the government, they will automatically, as it were, reveal, for example, the extent to which work in the same field is being performed by different services, and thus furnish the information that is essential to a consideration of the great question of the better distribution and coördination of activities among the several departments, establishments, and bureaus, and the elimination of duplications of plant, organization and work. Through them it will also be possible to subject any particular feature of the administrative work of the government to exhaustive study, to determine, for example, what facilities, in the way of laboratories and other plant and

equipment, exist for the prosecution of any line of work and where those facilities are located; or what work is being done in any field of administration or research, such as the promotion, protection and regulation of the maritime interests of the country, the planning and execution of works of an engineering character, or the collection, compilation and publication of statistical data, or what differences of practice prevail in respect to organization, classification, appointment, and promotion of personnel.

To recapitulate, the monographs will serve the double purpose of furnishing an essential tool for efficient legislation, administration and popular control, and of laying the basis for critical and constructive work on the part of those upon whom responsibility for such work primarily rests.

Whenever possible the language of official statements or reports has been employed, and it has not been practicable in all cases to make specific indication of the language so quoted.

CONTENTS

CHAPTER PAGE

FOREWORD

I. HISTORY 1

Early Organized Meteorological Observations 1
Early Weather Forecasts 2
Creation of a National Weather Service 3
Organization of the Signal Service of the U. S. Army . 4
Transfer of the Weather Bureau to the Department of Agriculture 6
Development of the Meteorological Work of the Government 6
Weather Observation and Forecasts 7
State Weather Services 9
Special Weather Forecast Services 9
River Observations and Flood Warnings 10
Marine Meteorological Work 10
West Indies Storm Warnings 13
International Coöperation 13
Aërological Observations 14
Meteorological Studies 14
Concentration of Records 14
Publications 15

II. ACTIVITIES 16

Weather Reporting and Forecasting 17
Climatological Work 24
Work in Marine Meteorology 26
Work in Agricultural Meteorology 27
Work in Aërology 29
Reporting Effects of Weather on Highways 30
Reporting and Forecasting River Stages 30
Studies in Solar Radiation 32
Studies in Seismology 32
Studies in Volcanology 33
Maintaining and Operating Telegraph Lines 34
Instrument Equipping and Testing 35
Other Meteorological Work 35
Evaporation Work 35
Atmospheric Moisture 35
Cyclones and Anticlones of the United States . . . 36
Treatise on Weather Forecasting 36
Mountain Snowfall 36
Climate of Africa 36
Meteorological War Service 36

CHAPTER PAGE

III. ORGANIZATION 38
Administrative and Scientific Division 38
Stations and Accounts Division 38
Supplies Division 39
Printing Division 39
Telegraph Division 39
Library 39
Editorial Division 39
Forecast Division 40
Forecasting Division 40
Climatological Division 40
Division of Agricultural Meteorology 41
Marine Division 41
Aërological Investigations Division 42
River and Flood Division 42
Solar Radiation Investigations Division 42
Seismological Investigations Division 43
Instrument Division 44
Stations 44

APPENDIX

1. Outline of Organization 47
2. Classification of Activities 54
3. Publications 56
4. Laws 58
5. Financial Statement 68
6. Bibliography 71
Index 83

THE WEATHER BUREAU: ITS HISTORY, ACTIVITIES, AND ORGANIZATION

CHAPTER I

HISTORY

The United States Weather Bureau was originally a branch of the Signal Service, later the Signal Corps of the U. S. Army, whence it was transferred on July 1, 1891 to the Department of Agriculture.

Weather observations, whether made for the purpose of forecasting, for the collection of climatic data, or for the discovery of laws governing atmospheric phenomena, require the coöperation of a large army of collaborators scattered over an extensive area. In the United States there are at present about 6000 meteorological stations at which over two and one-half million observations are made every year, mostly by volunteers who receive no compensation for this service. It is estimated that there are 31,000 meteorological stations throughout the world.

Early Organized Meteorological Observations. The first record of organized meteorological observations dates back to 1654 when the Duke of Tuscany distributed meteorological instruments and secured the coöperation of several observers in Italy and adjacent countries. These records were kept up for about thirteen years. This effort was followed during the next century by similar ones in France, England, and Germany. The first comprehensive collection of meteorolog-

ical observations prior to the nineteenth century was made from 1780 to 1792 by the Meteorological Society of the Palatinate, which covered eleven countries, including observations at two points in the United States. The records of these observations have been preserved.

In the United States the first steps for organized meteorological observations were taken in 1817 by Josiah Meigs, Commissioner-General of the Land Office, who established a system of tri-daily observations at the various land offices. In 1819, the Surgeon-General of the Army also began a system of meteorological observations at military posts throughout the country. The Patent Office in 1841 and the Smithsonian Institution in 1847 inaugurated systems of organized observations. The Engineer Corps of the U. S. Army also recorded meteorological observations. State authorities in New York and Pennsylvania engaged in such work in 1825 and 1837 respectively.

Early Weather Forecasts. With the meteorological data thus accumulated, the pioneers of meteorology in the United States, Redfield, Coffin, Espy, Loomis, Maury, and others, were enabled to study the characteristics of storms and other meteorological phenomena in this country, to observe and establish the progressive movement of atmospheric disturbances from west to east or from southwest to northeast, and to point out the practicability of forecasting the approach of such disturbances by telegraphing simultaneous observations to the forecasters. The first published weather forecasts were based on telegraphic simultaneous observations inaugerated in 1849 by Prof. Henry of the Smithsonian Institution. By an arrangement with the telegraph companies, each local operator gave to his division superintendent and the local newspapers a statement of the temperature, wind, and weather, and all of them were telegraphed to the Smithsonian Institution where they were daily exhibited on a large wall map until the year 1861. These reports were frequently used by Prof.

Henry to predict or show the possibility of predicting storms and weather; a matter that he had frequently urged on the attention of Congress. The advent of the Civil War put an end to this telegraphic service.

The plans for the present Weather Bureau were originated in part by Prof. Cleveland Abbe, director of the Mitchell Astronomical Observatory at Cincinnati, Ohio, who during the years 1868 to 1870 gave a concrete demonstration of the practicability of rendering a definite daily service in the forecasting of the weather. Under the auspices of the Cincinnati Chamber of Commerce, and with the coöperation of the Western Union Telegraph Company, the observations of about thirty stations, beginning on September 1, 1869, were daily collected by telegraph, and a synoptic chart was prepared on which weather forecasts or "probabilities" for a short period were based.

Creation of a National Weather Service. In 1869, Col. A. J. Myer, then at the head of the U. S. Signal Service, in sketching out a course of usefulness for his organization in peace time, suggested to the Secretary of War a scheme of weather reports and storm signals, which, however, could not be carried out in the absence of legislative authority.

About that time Prof. I. A. Lapham, a scientist of Milwaukee, one of Prof. Abbe's coöperating observers, submitted a petition to the Chicago Academy of Science for the establishment of a system of storm warnings for Lake Michigan. When this petition was handed for signature to Hon. H. E. Paine, a member of Congress from Wisconsin, he induced Prof. Lapham to supplant the petition by one addressed to Congress asking for a National Weather Service. The new petition was endorsed by many scientists, trade bodies, and other organizations, and presented to Congress. Gen. Paine introduced a bill providing for the establishment of a weather service as a part of the Military Signal Service.

This bill, which was in the form of a Joint Resolution, was

approved February 9, 1870 (16 Stat. L., 369). It provided "for taking meteorological observations at the military stations in the interior of the continent and at other points in the states and Territories of the United States, and for giving notice on the northern lakes and at the seacoast, by magnetic telegraph and marine signals, of the approach and force of storms."

Organization of the Signal Service of the U. S. Army. This new work was made a function of the Signal Service of the U. S. Army. The Signal Service at that time consisted of a Chief Signal Officer, with the rank of Colonel, a number of officers detailed from other branches of the Army, and men enlisted specially for that service.

Being a military service, the work of observation and general administration was placed in the hands of the officers and the enlisted men of the Signal Service, but the higher technical work from the beginning was directed and performed in a large measure by civilians, at the head of whom was Prof. Abbe. The observing stations were manned by sergeants, corporals, and privates of the Signal Service. The forecasting of the weather was originally done by civilians only, but later, at times by civilians and at times by commissioned officers. The meteorological research work in what became known as the "study room," and the work of testing, perfecting, and standardizing meteorological instruments and improving methods of observation was mainly performed by civilian scientists.

The weather service work of the new organization demanded a large number of men familiar with observational, theoretic, and practical meteorology. The commissioned officers detailed to Signal Service work were required to acquire meteorological knowledge by studying the available literature and consulting with and receiving instruction from leading meteorologists.

For the education of observers (enlisted men of the Signal

Service) a school of meteorology was added to the existing school of instruction in telegraphy and military signaling located at Fort Whipple (now Fort Myer), Virginia, the instruction of the observers consisting of courses in military tactics, signaling, telegraphy, telegraphic line construction, electricity, meteorology, and practical work in meteorological observation. Later, in 1882, a course for commissioned officers, covering meteorology, mathematics, electricity and laboratory work, was added to this school. This training school was abolished by order of the Secretary of War in 1886. After that time the work of training observers was relegated to the observer-sergeants at the various stations. Much attention was also given to the extension of meteorological instruction in high schools and colleges, with the view of recruiting observers from graduates who had taken such courses.

On June 16, 1880 an appropriation act was passed (21 Stat. L., 259) having a provision that "the Chief Signal Officer shall have the rank and pay of a brigadier-general." After this the title "Signal Service" was changed to "Signal Corps," although both titles appeared in subsequent legislation. The Signal Corps then consisted of a Chief Signal Officer with the rank of Brigadier General, second lieutenants who had been advanced from the ranks of observer-sergeants, and the men who had enlisted in the Signal Corps with the understanding that they were to remain in that service and who were trained at the Military School at Fort Myer. Other officers on duty with the Signal Corps were temporarily detailed from other branches of the Army. In addition, a force of civilian scientists was employed as above mentioned. When the Weather Service was transferred to the Department of Agriculture in 1891, the commissioned officers remained in the Signal Corps of the Army, which was divorced from the Weather Service, but nearly all the enlisted men were discharged and appointed to civilian positions in the Weather Bureau, the civilian scientists being also transferred.

Transfer of the Weather Bureau to the Department of Agriculture. The Weather Service was originally designed for the benefit of navigation on the sea coast and on the Great Lakes. Soon after its creation, however, its benefits also became appreciated in the interior districts by merchants and shippers, by navigators on the great rivers of the central valleys, and by railroad companies. Special warnings and reports on climatic conditions were demanded by farmers. In fact, within a few years after its creation, the observations, forecasts, and warnings of the National Weather Service, were utilized wherever industry or transportation was in any degree dependent upon the weather. But, while the work of the Weather Service was primarily devoted to responding to these daily needs of the public, it was also giving attention to the needs of climatology and to development along the lines of higher scientific work necessary to assure advancement in the art of weather prediction.

As the science of meteorology developed and as the demands of commerce, agriculture, and navigation with regard to warnings of storms, frosts, and other atmospheric disturbances and floods increased, the urgent need of a new organization, devoid of militarism, and with a more real scientific status, became apparent. This necessity was brought to the attention of Congress, and accordingly, on October 1, 1890, an act was approved (26 Stat. L., 653) transferring the Weather Service of the Signal Corps to the Department of Agriculture on July 1, 1891, and thus creating an independent bureau devoted to the sole purpose of a scientific meteorological agency and divorced from all military features. The transfer became effective July 1, 1891.

Development of the Meteorological Work of the Government. The observation stations of the U. S. Signal Service were located throughout the United States, in the principal cities, at important lake and seaports and at military posts, the locations being selected chiefly on account of their advantage

for forecast and storm warning purposes rather than for climatological reasons. Observations were made of the actual maximum and minimum temperature, the humidity of the air, the barometric pressure, the rainfall, the direction and velocity of the wind, the kind of clouds and the direction of their movement, and the state of the weather, whether clear, fair, cloudy, etc., much as is being done at the present day.

Weather Observations and Forecasts. The first meteorological observations of the new weather service were made on November 1, 1870. Until December 31, 1884 two sets of observations were made: One set, for telegraphic purposes, consisted of observations taken simultaneously at all stations, and the other consisted of observations made for climatic purposes.

The telegraphic observations were begun November 1, 1870, at 7:35 A. M., 4:35 P. M., and 11:35 P. M., Washington time. On August 25, 1872 the time of the night observation was changed to 11 P. M., and on November 1, 1879, the time of the other two telegraphic observations was changed to 7 A. M. and 3 P. M., Washington time. On January 1, 1887, 75th meridian time was substituted for Washington time, and the time of the night observation was changed from 11 P. M. to 10 P. M. Since July 1, 1888, only two observations are taken each day, at 8. A. M and 8 P. M., 75th meridian time.

Observations not telegraphed, but taken for climatic purposes were taken at 7 A. M., 2 P. M., and 9 P. M., local time, from January 1, 1871 to June 30, 1881. Additional daily observations were taken at noon, local time, from February 23, 1873 to December 31, 1879. Observations at Washington time, but not telegraphed, were taken daily at 11 A. M. from January 1, 1880 to December 31, 1884, and at 7 P. M. from July 1, 1881 to December 31, 1884. After the year 1884 the special observations for climatic purposes were discontinued because the general introduction of self-registering instruments for climatic and other scientific data had by that time obviated the necessity for taking them.

The telegraphic observations on which weather predictions were based were charted in Washington, where synopses of the actual conditions and forecasts for various sections were prepared and published. At a number of the principal stations the synopses and forecasts were printed, and copies were distributed by mail to the rural districts.

The first synoptic weather chart was issued on January 1, 1871, and the regular published weather predictions began February 19, 1871. These predictions were originally called "probabilities," and were made three times daily for such elements and periods in advance as seemed warranted by the maps, and for eight geographical districts. Beginning with October, 1872 predictions were regularly made for twenty-four hours in advance and for nine districts. In 1874 they began to be made for eleven districts and for four elements, namely, weather, wind, pressure, and temperature. No material change was made until July, 1885, when predictions were made for thirty-two hours in advance. Beginning with May, 1886, predictions have been made by states and parts of states instead of districts. Since July, 1888 predictions have been made thirty-six hours in advance, and beginning August 1, 1898 forecasts based on the evening reports have been regularly made for forty-eight hours in advance. The term "probabilities" as applied to predictions was changed to "indications" on December 25, 1876, and this was changed on April 1, 1889 to "forecasts" which term is still in use.

Until 1881 official weather forecasts were made only at the central office in Washington. In that year and during part of 1882 the observer at New York was permitted to make and publish local forecasts. The present system of local forecasts was not begun until 1890, when officers were assigned to St. Paul and San Francisco to make forecasts for their respective vicinities. The system of district forecasts was begun in 1894 when Chicago was established as a forecast center. At present there are five forecast districts, including that cen-

tered in Washington, and nearly every observer is authorized to make local forecasts.

In addition to the regular daily weather forecasts, a system of storm and wind signals was inaugurated, as a result of an appropriation act approved June 10, 1872 (17 Stat. L., 366) which provided: "For expenses of storm signals announcing the probable approach and force of storms throughout the United States for the benefit of commerce and agriculture"; and "that the Secretary of War be . . . authorized and required to provide in the systems of observation and reports in charge of the Chief Signal Officer for such stations, reports and signals as may be found necessary for the benefit of agriculture and commercial interests."

State Weather Services. In April, 1881 steps were taken by the Chief Signal Officer to encourage the establishment and secure the coöperation of weather services in the several states, mostly for the purpose of taking climatological observations and for extending the distribution of official forecasts and warnings of the National Weather Service. Two such services had already been privately established in Iowa and Missouri, the former having received some state aid. These efforts met with such success that within a few years nearly every state and territory had established such a service.

In 1887, when the National Weather service began the issue of weekly weather crop bulletins, the observers of the state weather services were mainly depended upon for the weather crop reports on which the statements in the bulletins were based. In time, these services gradually lost their character as state weather services, and their operation and control came entirely under the National Weather Bureau.

Special Weather Forecast Services. In September, 1881 the system of cotton belt observations and reports, and later in the same year, special warnings for the benefit of the sugar interests were inaugurated. These were followed by other similar special services which are mentioned in the chapter on activities.

In 1888 the cold-wave flag and many other weather signal devices were introduced, all of which were eventually reduced to a simple system of flag signals, now called "weather flags."

In 1902 it became possible, by means of wireless telegraphy, to send daily forecasts of the weather to vessels at sea, a service which continues to the present time with the coöperation of the Navy Department.

Finally, in 1908, the Weather Bureau began the issuing of forecasts of a week to ten days in advance, these forecasts being chiefly for the benefit of farmers, and covering mainly the two elements of temperature and precipitation.

River Observations and Flood Warnings. In 1871 the work of observing and reporting the stages of water in rivers was made one of the functions of the Signal Service, by a clause in an appropriation act. The first river observations were made in January, 1872. These observations were made at regular meteorological stations and also at other points along the principal rivers and their tributaries. The observers at the latter were employed on part time and were paid usually for each observation, which required but a very small part of their time. These observations consisted of reading the river gage and measuring the precipitation, and reporting the results to a central station.

Marine Meteorological work. In addition to the land observations begun in November, 1870, attention has been given, almost from the beginning of the Weather Bureau, to the importance of obtaining meteorological data from vessels at sea, from islands in the Atlantic, particularly the West Indies, and from foreign countries.

In May, 1871, circulars were sent out to navigators and vessel owners requesting tri-daily simultaneous observations at sea, to be transmitted to the Weather Bureau whenever the vessels arrived. These efforts met with considerable response. The results of the observations were used in the study of marine meteorology and also in the preparation of a daily weather chart for the northern hemisphere. In 1887 all marine meteor-

ological work under the supervision of the Signal Service was transferred to the Hydrographic Office of the U. S. Navy Department.

On June 24, 1904 the President of the United States appointed an interdepartmental board, consisting of representatives of the Departments of War, Navy, Agriculture, and Commerce and Labor to consider the question of wireless telegraphy. In this connection it also dealt with the question of duplication of meteorological work. On July 12, 1904 the board made its report, which was approved by the President on July 29, 1904, the President directing that the several departments concerned put its recommendations into effect. The recommendations that concerned the Weather Bureau and its work and the meteorological activities of other departments represented on the board were as follows:

That the necessary steps be taken to have the Weather Bureau of the Department of Agriculture turn over to the Navy Department all coastwise wireless telegraph apparatus now under its control, and such material as it may have in its possession which can be utilized by the Bureau of Equipment of the Navy Department, and that proper transfers of funds for this purpose be made;

That the Weather Bureau of the Department of Agriculture furnish to the Hydrographic Office of the Navy, and to the naval wireless telegraph stations, or to other portions of the public service, such meteorological data as it or they may desire at no cost to them;

That the Department of Agriculture shall continue the work of its meteorological vessel-reporting and storm-warning stations, as now constituted and provided for by law, and continue the control of seacoast telegraph systems, except wireless systems;

That all meteorological reports from vessels of war or commerce or other sailing craft, now being forwarded direct to the Hydrographic Office of the Navy, shall be forwarded direct to the Weather Bureau, and the control of ocean meteorology

be transferred to the Department of Agriculture which already has ample law for doing this work;

That the estimates for the support of the Hydrographic Office of the Navy, or any other office of the Navy, for the next and succeeding fiscal years, do not contain any provision for the making of ocean forecasts, or for the publication of meteorological data, other than such as may be needed by the hydrographer of the Navy for use on the pilot and other charts, which data shall be furnished by and credited to the Weather Bureau;

That it is the opinion of this board that no meteorological work need or should be done by any portion of the Navy for the purpose of publication, or for the making of forecasts or storm warnings; that all such duties, being purely civil, should devolve upon the Weather Bureau of the Department of Agriculture in accordance with the organic act creating that bureau;

That the wireless stations of the Navy Department shall, without charge to the Agriculture Department, receive and promptly transmit to the ocean or to islands, or to other places where the information can be made useful, the storm warnings of the Weather Bureau;

That the Navy Department shall request all vessels having the use of its wireless stations for the receipt of messages, to take daily meteorological observations of the weather when within communicating range and to transmit such observations to the Weather Bureau, through naval wireless stations, at least once daily, and transmit observations oftener when there is a marked change in the barometer and that there shall be no charge against the Agriculture Department for these observations, or for the transmission thereof.

The marine meteorological work of the Hydrographic Office of the Department of the Navy was consequently transferred to the Weather Bureau on December 1, 1904, and the wireless telegraphy service of the Weather Bureau was turned over to the Department of the Navy.

West Indies Storm Warnings. In 1872 three signal service stations were opened in the West Indies, to which three more were added in 1874. On July 7, 1898 Congress enacted a provision appropriating money for the West Indies storm warnings service. This service was established with headquarters at Kingston, Jamaica, which were later removed to Havana, Cuba. The first reports were received August 9, 1898. The headquarters are now at San Juan, Porto Rico, and the service comprises twenty-two observation stations, of which three are at naval stations.

International Coöperation. On November 13, 1871 a system of international exchange between the weather bureaus of the Dominion of Canada and the United States was inaugurated thus extending the area of the weather map northward.

In 1873 the Chief Signal Officer invited all the nations individually to coöperate with him in making and collecting one daily simultaneous observation. After several of the nations had promised coöperation, the plan was presented to and was approved by the First International Congress of Meteorologists at Vienna in September of that year, and steps were taken to have these observations made in the several countries and reported to Washington.

As a result of this action, it became possible to begin on July 1, 1875 the publication of the *Bulletin of International Simultaneous Observations,* to which daily maps were added in 1877. It was published for distribution among coöperative observers only, and continued daily through 1887, with monthly and annual summaries through 1889. The transfer of marine meteorological work to the Hydrographic Office in 1887 interrupted this publication, and no charts of similar scope have ever been prepared since. In 1907 the Forecast Division began making daily, in manuscript, a weather map of the Northern Hemisphere, based on telegraphic reports from stations in this country and a small number of foreign stations. This chart was printed from the beginning

of 1914 until interrupted by the World War. Its publication in manuscript has been resumed.

Aërological Observations. Efforts to obtain meteorological data for the upper atmosphere date from the very beginning of the Weather Bureau. From 1871 to 1885 occasional balloon observations of the upper atmosphere were made by an aëronaut who had volunteered his services. On July 21, 1873 a meteorological station was established on the summit of Pike's Peak, and other stations were subsequently established at elevated points in the United States. Extensive experiments in the construction of kites were made by the Weather Bureau in 1895, and in 1898 kite observations were made daily, as far as weather permitted, at seventeen Weather Bureau stations from April to November. The results have been published in Weather Bulletin F. Special aërological investigations were initiated in November, 1904 at Mount Weather, Virginia, this station being later removed to Drexel, Nebraska. A considerable extension of this work was made possible in 1918 by an item included in the army appropriation act for taking care of the urgent needs for additional information covering free air for military operations during war, which item was transferred to the agricultural appropriation act for the fiscal year 1919 and has since been so carried.

Meteorological Studies. From time to time special meteorological studies and work in allied fields was undertaken, such as evaporation, volcanology, seismology, solar radiation, etc., which will be considered in the chapter on activities.

Concentration of Records. In 1873 the Surgeon General of the Army, the Secretary of the Smithsonian Institution, and the Chief of Engineers of the United States Army relinquished their meteorological work and transferred all earlier records to the Signal Service. The official climatological records of the country were thus concentrated in the Signal Service archives.

Publications. On January 1, 1873 the Signal Service began the issue of a *Monthly Weather Review,* which contains climatological data, results of meteorological studies, and other similar information. Its publication continues to the present time. It now includes all the features of a general journal of meteorology, in addition to current statistical information.

CHAPTER II

ACTIVITIES

The functions of the United States Weather Bureau are defined in the duties prescribed for the Chief of the Weather Bureau in the act approved October 1, 1890 (26 Stat. L., 653), Section 3, as follows:

The Chief of the Weather Bureau, under the direction of the Secretary of Agriculture, shall have charge of forecasting the weather; the issue of storm warnings; the display of weather and flood signals for the benefit of agriculture, commerce and navigation; the gauging and reporting of rivers; the maintenance and operation of seacoast telegraph lines and the collection and transmission of marine intelligence for the benefit of commerce and navigation; the reporting of temperature and rainfall conditions for the cotton interests; the display of frost, cold-wave, and other signals; the distribution of meteorological information in the interest of agriculture and commerce and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States, or are essential for the proper execution of the foregoing duties.

Since its creation in 1870 the activities of the Weather Bureau have been chiefly devoted to the rendering of such direct practical service as would best meet the immediate needs of agriculture, commerce, and transportation, or what has been called "applied meteorology." While the importance of climatological data and of technical investigation and study in the field of meteorology is recognized, the expenditures of time and money by the Weather Bureau for such purposes have been comparatively small.

Meteorological observations are made by the Weather Bureau for the purpose of forecasting the weather, for the ac-

cumulation of climatological data, and for material to be used in technical meteorological study. They consist of observations of actual weather conditions made and recorded at specified times by observers, and of continuous records made by self-registering instruments. The former only are used as bases for the weather forecasts.

In addition to the meteorological work the bureau gives attention to observing the stage of the water in rivers and issuing of flood warnings and stage forecasts, and to studies in solar radiation, seismology, and volcanology.

Weather Reporting and Forecasting. For the purpose of weather forecasting as well as for climatological uses, observations are regularly made at 8. A. M and 8 P. M., 75th meridian time at about two hundred stations in the United States, Alaska, Hawaii, and Porto Rico. They consist of readings of the barometer, dry and wet bulb thermometers, the anemometer, the wind vane, the rain and snow gages, and the condition of the sky. All occasional phenomena such as thunderstorms, fog, smoke, halos, etc., are also noted.

For forecast purposes the observations are immediately telegraphed to the central office and to the other forecast centers, the telegraphic reports consisting of the current temperature, atmospheric pressure, humidity, precipitation, direction of the wind, state of the weather, velocity of the wind, character, quantity and movement of the clouds, maximum and minimum temperature since the last observation, and other phenomena when they occur, such as marked barometric changes, frosts, thunderstorms, high wind velocities, etc. In reporting the atmospheric pressure, the barometric readings are corrected to sea level, so that all may show pressures for the same plane.

Since the development of radio telegraphy it has become possible to supplement the telegraphic reports from mainland stations with reports made on distant islands in the north Pacific and in the West Indies and on ships at sea. By an arrangement made with steamship companies, meteorological ob-

servations are made on upward of one hundred vessels navigating the coastal waters of the middle and south Atlantic states, the Gulf of Mexico, the Caribbean Sea, and the Pacific Coast, and transmitted by wireless to shore stations, and thence to the central office of the Weather Bureau. The reports are charted on the twice-daily synoptic charts and serve as an aid in making forecasts and giving warnings, as they frequently give information of sub-tropical or ocean storms before they can be observed at the mainland stations.

For economy in transmission, the observational data from the two hundred regular Weather Bureau Stations to be telegraphed for forecast purposes, are put into cipher according to a code, of which one word indicates the value of two and sometimes three elements, such as barometric pressure and temperature in one word, direction and velocity of the wind and maximum or minimum temperature in another single word, etc. By this means an entire observation can be expressed by a telegraphic cipher message of four or five words, which if expanded into descriptive language would require from thirty to forty words. The coding system is so simple that with very little practice the messages can be readily deciphered without reference to a code book. The work of observation, calculation, coding, and delivery for telegraphic transmission is done within fifteen minutes, the work of observation being begun at 7:45 A. M. and 7:45 P. M. to allow for this time period.

The transmission of the telegraphic messages is done by means of a circuit system, which was inaugurated at the very beginning of the Weather Service. By its arrangement the various transmission lines are grouped into circuits. From shortly before 8 A. M to 9:30 A. M. and 8 P. M to 9:30 P. M., the necessary telegraphic lines in each circuit are held open for the meteorological dispatches to the exclusion of all other business. When the transmission of messages begins, all the men on each circuit are at hand with their messages so that the instant one dispatch is sent another succeeds it, until all

on the circuit are disposed of. As the messages are clicked the operator at each station on the circuit takes down all the dispatches which pass over it. When one circuit is through with its dispatches another circuit joins the preceding one, and its own together with all the accumulated reports are interchanged, and so on. By this "circuit" system about 175 coded weather observations are reported to the central office in Washington twice daily. By the same means 140 stations connected directly with the twenty-one circuits receive such a number of observations as is adequate to their needs. In addition to the circuit reports, daily observations are received from about forty other points by special message and cablegram and about fifty from ships at sea by wireless.

With the aid of these reports of simultaneous observations, weather forecasts are made twice each day by five forecast officers, each for a portion of the United States comprised within his district. The forecaster of the eastern district of the United States, whose office is in Washington, has supervising control over forecasts made in all the other districts. Daily forecasts are also made by local forecasters at most stations throughout the country. In addition to the daily forecasts, weekly forecasts are made of temperature and weather, and special warnings are issued of important impending weather changes which seriously affect specific interests.

The telegraphic reports of meteorological observations sent to the district centers are immediately entered upon outline maps. At the central office five such maps are made up. Map A shows the actual weather conditions observed at each station; that is, air pressure, temperature, velocity and direction of the wind, amount and areas of rainfall, and the state of the weather. Maps B and C show for pressure and for temperature, respectively, the changes in twenty-four hours, and the departures from the normal. Map D shows the amount, kind, and direction of upper and lower clouds and the areas of complete cloudiness. Map E shows the wind velocity and direc-

tion, at the surface and at various elevations in the air, such as 250, 500, 1000, 1500, 2,000, etc., meters.

By studying these maps, and by comparing the data with reports of preceding observations, the forecast officers are enabled to trace the paths of storms and other atmospheric disturbances from the time of their appearance to the moment of observation and to measure their progress; and because of an experience of many years, they can usually forecast their position thirty-six to forty-eight hours in advance. These daily forecasts by district forecasters are made at about 9:30 in the morning and in the evening, and usually cover temperature, wind, and general weather conditions for the several state units.

Twice-daily weather forecasts are also broadcast by radio telegraphy from a considerable number of wireless stations maintained by the Post-Office Department and from private wireless plants throughout the country.

The evening forecasts are distributed mainly through the various press associations for publication in the morning papers. The morning forecasts are given to the evening papers, and are telegraphed to about 1600 principal points for further dissemination by telegraph, telephone, wireless, and postal service. They are displayed by means of temperature and weather flags and printed on weather maps, bulletins and cards posted in public places throughout the United States, especially in post offices, hotels, stores, corridors and elevators of office buildings, railway stations, etc.

The supervising forecaster in Washington has immediate supervision over the forecasts made in the other districts, and if he disagrees with the latter, he notifies the respective forecasters in time to enable them to revise their forecasts.

At the important stations weather maps are printed containing the data indicated on Map A, above mentioned. These maps are distributed by mail and messenger and are displayed in public places. In addition to the data indicated by figures and symbols, these maps contain a printed synoptic statement

in text of the weather conditions and forecasts for the district or localities in which they are distributed. The work of observing, coding, telegraphing, deciphering, and charting data, and making and publishing the twice-daily forecasts is accomplished within a space of two hours.

Daily wireless forecasts of the wind and weather to be expected along the transatlantic steamship lanes eastward from the Atlantic ports to the Grand Banks of Newfoundland and along the Atlantic Coast, in the Gulf of Mexico, and in the Carribean Sea, for the guidance of vessel masters, are issued each day and are sent to steamship company offices and transmitted by wireless, with the coöperation of the Navy Department, to vessels at sea. The messages containing the forecasts also include statements of actual weather conditions in such detail that the mariners may prepare their own weather charts on outline maps furnished them by the Weather Bureau. A similar service is also in operation on the Pacific coast district and the Great Lakes.

Twice-daily aërial forecasts are made by the district forecaster in Washington for the benefit of the aëroplane services of the Post Office, the War and Navy Departments, and for other aviators. For this purpose the country is divided into thirteen districts, a forecast being made for each district. The forecast consists of a message indicating the wind direction and velocity at the surface and at higher altitudes, and whether the wind and sky will be favorable for flying.

Daily forecasts are also made at nearly all the local stations, such forecasts covering territory within a radius of twenty miles of the station. They consist of a statement of the probable weather, temperature, and wind, and, during the winter months, the probable minimum temperature. These forecasts may or may not be in accord with the district forecasts, as the local forecaster is sometimes in a better position to make a forecast for his particular locality than the district forecaster whose forecast is made for a whole state or a large portion of

a state. The local forecaster may even ignore a cold-wave warning if the cold wave has already arrived in his locality or if he has reason to think that it will not reach his locality.

The local forecasters at many of the Weather Bureau stations also make what are designated as "shippers' forecasts." These are regularly made during months when temperatures are likely to be injurious to shipments of perishable goods and produce. They are made in addition to the cold-wave and frost warnings, and indicate the approximate degree of cold that is likely to be experienced along various transportation routes.

All daily local forecasts must be submitted by mail immediately to the office in Washington, together with the district forecasts. If they differ, the difference must be underscored. These forecasts are later checked up with the actual weather conditions which follow, and a record is kept of the efficiency of each local forecaster as ascertained in this way. When vacancies occur among the district forecasters, they are filled by selection from the ranks of those local forecasters who have attained the highest percentage of verification of their forecasts.

The meteorologists in charge of the stations at Juneau, Alaska, and San Juan, Porto Rico, are also authorized to make district forecasts. The former, who receives reports from points in Alaska and along the Aleutian Islands by telegraph, wireless, and cable, makes forecasts only when the weather reports received make it possible. The meteorologist at Porto Rico, who receives reports in the same way from West Indian points, only gives warning of approaching hurricanes and other severe storms.

Weekly forecasts of the general weather and temperature conditions are made every Saturday for the week beginning the ensuing Monday. These are made by the forecaster in Washington for each of the nine districts into which the country is divided. These forecasts indicate the general weather outlook for the week, especially as to rain and temperature

changes, cold waves and frosts, being intended for the benefit of the agricultural and commercial interests.

In addition to the regular daily and weekly weather forecasts, special warnings of hurricanes, storms, cold waves, heavy snows, and frost are issued whenever the occasion arises. Of these, the warnings of storms and hurricanes, issued for the benefit of the marine interests, are of the most importance. Such warnings are displayed by means of storms flags and lanterns at more than 300 points on the Great Lakes and along the Atlantic, Pacific, and Gulf coasts. For this purpose reports from the West Indies and Central America are especially valuable, as they enable the Weather Bureau to forecast with great accuracy the approach of hurricanes, which sometimes sweep the Gulf and Atlantic coasts from July to October. The storm warnings for the Great Lakes and the East Gulf and Atlantic coasts are issued by the Washington forecaster, those for the West Gulf coast, by the district forecaster at New Orleans, and those for the Pacific Coast, by the district forecaster at San Francisco. It is claimed [1] that "scarcely a storm of marked danger to maritime interests has occurred for years for which ample warnings have not been issued from twelve to twenty-four hours in advance," and that "the sailings of the immense number of vessels in our ocean and lake traffic are largely determined by these warnings. Such warnings displayed for a single hurricane are known to have detained in port on our Atlantic coast vessels valued with their cargoes at over $30,000,000."

Cold-wave warnings, that is, warnings of sudden and decided weather changes to temperatures below the freezing point, are issued by the district forecasters from twenty-four to thirty-six hours in advance throughout the threatened regions. The warnings are distributed by means of the telegraph, telephone, and mail services to all places receiving daily forecasts, and to some additional points, and by cold-wave flags displayed at regular Weather Bureau and subdisplay sta-

[1] The Weather Bureau, Williams, p. 33.

tions. These are intended to give warning for the protection of property, especially perishable goods in storage or transit.

Frost warnings are issued primarily for the benefit of growers of fruit and vegetables liable to injury by frost. They are also issued by the district forecasters whenever frost or freezing weather is expected in regions where it might be injurious to growing fruits or other vegetation, especially tobacco, sugar, cranberries, and garden vegetables. It is claimed [1] that "the early truck raising industry, so extensively carried on in the regions bordering on the Gulf and south Atlantic coasts and in Florida . . . is largely dependent for its success on the coöperation of the Weather Bureau in this particular, and the growers of oranges and other fruits in Florida and California have received great benefit," also that "the deciduous fruit districts of Washington, Oregon, Idaho, Utah, Colorado, and throughout the east, rely upon the warnings of the bureau to guide them in smudging and heating their orchards on the occurrence of frost or freezing weather during the blossoming period."

"Fire-weather" warnings are issued by district forecasters whenever such periods of dry weather or winds are expected as are favorable to the inception or are liable to facilitate the spread of forest fires. These warnings enable foresters in Washington, Oregon, Idaho, California, and Minnesota, to take special precautions at such times.

In addition to the forecasts mentioned above, special forecasts are made of weather conditions for the guidance of farmers in spraying operations for insect pests and fungi and in the harvesting of hay and grain crops, for the cranberry industry of Massachusetts, New Jersey, and Wisconsin, and for various other industries that are partially or wholly dependent on accurate forecasts of weather and temperature changes.

Climatological Work. The observations made at 8 A. M.

[1] Ibid., p. 35.

and 8 P. M., 75th meridian time at about 200 regular observation stations are also recorded and published for climatological purposes. In addition to the observations made at the specified times, self-registering instruments at nearly all these stations are keeping a constant record of the temperature, barometric pressure, direction and velocity of the wind, sunshine, and rainfall. These records are made automatically on sheets which revolve on drums operated by clock-work.

In addition to the regular stations with paid employees, the Weather Bureau has the voluntary services of more than 4500 coöperative observers, so scattered throughout the United States as to furnish a fairly complete climatological record for every part of the country. These observers usually take one observation a day of the maximum and minimum temperature, the rainfall, state of the sky and direction of the wind, but some, of the rainfall only. Standard instruments and instrument shelters for this purpose are furnished by the Weather Bureau.

The observations made by voluntary observers are entered in triplicate on original record forms supplied by the Weather Bureau, one copy being retained by the observer, one sent each month to the section center, and one to the chief office in Washington.

For the purpose of climatological observations and reports, the country is divided into forty-two local sections, each section generally covering a state; there being a few cases where two or more states are grouped into one section. Each section has a central station in charge of a paid employee of the Weather Bureau, who has general supervision over the observational work of the coöperative stations, and receives, publishes, and distributes the climatic data for the section.

At each section center there is published a monthly periodical entitled *Climatological Data,* which contains a general summary of the weather, temperature, humidity, precipitation, wind, sunshine, and cloudiness, and mention of any unusual meteorological phenomena; detailed tables of meteorological

observations from many stations for each day of the month, and summary tables and comparisons with previous years; also river data where such are obtained. Similar information is published for the entire country in the *Monthly Weather Review,* issued at the central office in Washington, and in the Annual Report of the Chief of the Weather Bureau.

In addition to the regular climatological data, special efforts are being made to secure more complete statistics on the occurrence and distribution of hail and the amount of damage done by tornadoes and other wind storms, for publication in the monthly and annual reports and for scientific study.

The coöperative stations are inspected about once in three years for the purpose of testing the instruments and maintaining personal contact between the observers and the officers of the bureau.

The climatological data are used primarily for establishing the weather characteristics of each locality, information which is of greatest value to farmers in adapting their crops to such conditions, to manufacturers in many lines of industry in determining the location of plants, to emigrants desiring to locate advantageously, to physicians in advising patients, etc. Much use is also made of these records by railroads, business men, and others for reference, especially when needed as evidence in court concerning weather conditions on particular days in certain localities, as in suits for damages to perishable goods in storage or transit.

Work in Marine Meteorology. The Weather Bureau, with the coöperation of navigators, collects the results of meteorological observations at sea. All coöperating navigators take observations at Greenwich mean noon time, when they record the latitude and longitude, take barometric readings, and note the direction and velocity of the wind and the state of the weather. This information is recorded on blanks furnished by the Weather Bureau, which are returned by mail whenever the vessel lands.

This meteorological information when received is charted at the office in Washington, and summaries of the weather conditions over both the North Atlantic and North Pacific oceans are prepared and published in the *Monthly Weather Review*. The tracks of the more important storms, as ascertained from these reports and other data, are furnished to the Hydrographic Office of the Navy Department under a departmental arrangement and an act of Congress, for publication on the pilot charts. The same data form the basis of the average values of weather elements shown on the Pilot charts, including atmospheric pressure, air temperature, gales, fog, etc. They are also of value in the settlement of admiralty cases.

The information thus compiled and distributed is very important to navigators, for the safe and economic operation of vessels depends largely upon a knowledge on the part of their officers of the weather of the oceans.

Work in Agricultural Meteorology. This group of activities consists of collecting information of special value to the agricultural interests and supplying it in the form of daily or weekly bulletins.

In the corn and wheat region, from April to September, daily telegraphic reports of temperature and rainfall at stations in that region are received at a central station, where a summary is prepared and telegraphed to eighteen points in the region, at each of which the summary is published and distributed.

In the cotton region, from April to October, daily telegraphic reports of temperature and rainfall at special stations in the eleven principal cotton states are received at fifteen district centers, at each of which, and at eleven other points, daily bulletins containing this information are prepared and published. Weekly bulletins and charts giving the temperature and rainfall over the cotton states are published at New Orleans.

Similar special services are rendered for the rice, sugar, tobacco, truck, alfalfa, and cattle regions in the United States.

In the fruit region, in addition to the cold-wave and frost warnings already mentioned, expert information is given to fruit growers concerning the temperatures to be expected and the necessity for lighting fires in orchards. Studies are also being made concerning temperature at various altitudes in the fruit-growing states, the weather effects on fruit trees and on the activity of damaging insects, and the efficacy of orchard heaters.

Weekly data concerning temperatures and rainfall and their effects upon the crops and farm operations are received from special observers at all the state section centers, where synopses are prepared and telegraphed to the Weather Bureau in Washington. These reports are issued at 11 A. M. Wednesday, and cover the weather conditions up to 8 A. M. Tuesday. The collective information is published in the *Weather, Crops and Markets,*[1] issued in Washington by the Department of Agriculture, while local bulletins are published at the section centers in each state.

In the collection and distribution of this information the Weather Bureau depends largely upon the services of voluntary observers who receive no compensation for their services. Efforts are being made to secure the establishment of meteorological stations at the agricultural experiment stations.

Among the studies that are being made in agricultural meteorology, in coöperation with other bureaus of the Department of Agriculture, are: The effect of temperature, rainfall, and snow on winter wheat; the effect of different weather factors on the production and yield of corn, cotton, and other crops; the influence of the weather on the progress of the cotton harvest, and the relation of climate to the geographic distribution of farm products and types of farming in the United States; cultivation and rainfall in the Great Plains; the relation between precipitation and the grazing capacity of

[1] Prior to 1922 this information was published in the *National Weather and Crop Bulletin.*

ranges; and the seasonal distribution of precipitation and sunshine in the United States.

Work in Aërology. Observations of the upper air are being made for the purpose of providing information of immediate practical value to aviators and of throwing light upon the problems of dynamic meteorology; that is, to secure more information concerning the general circulation of the atmosphere. These observations are made by means of kites and free or "pilot" balloons. The kite observations include daily flights at six stations, and whenever possible, continuous series of such flights covering periods of twenty-four to thirty-six hours. By means of self-registering instruments, records of air pressure, temperature, humidity, and wind direction and velocity are obtained. Brief summaries of these records and observations are telegraphed daily to the central office.

Observations by means of pilot balloons are made twice daily at the kite stations and at seven other Weather Bureau stations in the United States, and the indicated wind conditions at various heights are telegraphed to the central office and other district forecast centers for use in furnishing advice to the military, naval, and postal aviation services. Observations made by the army and navy aërological stations are also telegraphed to the Weather Bureau.

Aërological stations have also been established by the Weather Bureau at Key West, Florida, and at San Juan, Porto Rico, which together with similar stations organized by the War and Navy Departments in the West Indies and Gulf States form a network of stations which furnish information concerning the origin, direction, and speed of movement of hurricanes, thus rendering much aid in the study of these destructive storms and in forecasting their direction and rate of movement.

While aërological observations and studies have been made for many years under the general authority to perform meteorological work, aërology was first specifically mentioned in

the agricultural appropriation act of June 30, 1914 (38 Stat. L., 415, 417). The army appropriation act of May 12, 1917 (40 Stat. L., 40, 43) for the fiscal year ending June 30, 1918 had an item of $100,000 to be expended under the direction of the Secretary of Agriculture "For the establishment and maintenance by the Weather Bureau of additional aërological stations, for observing, measuring and investigating atmospheric phenomena in the aid of aëronautics." Since that time similar provisions of slightly smaller amounts have been included in the annual agricultural appropriation acts.

Reporting Effects of Weather on Highways. The "highways weather service" was formally authorized during the fiscal year 1919. Daily reports are received at certain central stations, from voluntary local observers, of the conditions of the roads as affected by the weather in the surrounding regions and over certain main highways. In cases where the stations are centers of a corn-and-wheat or cotton region service, the reports are transmitted by telegraph by the addition of a code-word in the regular daily corn-and-wheat or cotton report. In other instances the reports are transmitted to the central stations by mail by means of franked postal cards. The reports are brought together at the central stations where daily bulletins are issued giving information of the condition of the roads, the effect of the weather thereon, and other similar information of value to automobilists and to those who are engaged in the transportation of goods by truck. Such bulletins are issued from sixty-two stations located in thirty states.

Reporting and Forecasting River Stages. The reporting of the stage of water in rivers is an activity of the Weather Bureau which has been authorized in appropriation acts since 1871. Its purpose is to safeguard life and property from destruction by floods and to aid river navigation by publish-

ing and forecasting the stage of the water in rivers and giving warning of floods.

The river and flood service is organized under sixty-eight district centers, to each of which is assigned one or more rivers, and in the case of the larger rivers, a portion of the stream. Daily readings of gage heights for at least part of the year are made at 566 stations, and occasional readings as circumstances may require, at seventy-two stations. Most of these stations also measure rainfall. In addition, 113 stations make continuous records of rainfall, which at times of excessive rains are telegraphed for gage forecast purposes, and 218 stations report only in case of heavy rains. The rainfall measurements at all the other regular and coöperative meteorological stations are also available for hydrological studies.

The river observations consist of a daily reading of the river gage, which is indicated in feet and tenths above a certain zero mark, usually the low-water mark of the station. These observations are reported by mail or telegraph to the district center, together with the rainfall and the weather condition.

The meteorologist in charge of the district center uses these reports as a basis for making a daily forecast of the expected rise and fall, if the river is one on which navigation is carried on. Special attention, however, is given to the issue of flood warnings, particularly when damages are expected to result from the floods. In such cases the expected crest stage of the flood is indicated in the warning as accurately as possible and with as much advance notice as can be given. In practice it is customary to set a provisional crest stage at the earliest possible moment and then revise it from day to day as the flood develops. In short fast-running streams, the period of advance notice is necessarily limited to from twelve to twenty-four hours, but on the longer, or on some of the shorter sluggish streams it is possible to give from three to seven days advance notice of floods.

In the river-stage forecasts and flood warnings the forecaster takes into consideration, among other things, the amount and

intensity of precipitation, the run-off and ground absorption, the gage relation between points and rate of flow, and the storage capacity of the river channel and overflow areas.

Studies in Solar Radiation. This activity consists of observing and measuring solar radiation at the earth's surface. Continuous records are kept of the total amount of radiation received on a horizontal surface from the sun and sky. Measurements are made of the rate at which heat is received at the surface of the earth by radiation during the day from the sun and from the sky; the heat lost at night; and the relation of these measurements to the atmospheric conditions. From these radiation measurements, which are based on observations at four stations, compilations are made of the diurnal and annual variations in radiation intensity with geographical position in the United States, and the variations which depend principally upon latitude, altitude, and the vapor contents of the atmosphere.

Studies are also being made to determine sky brightness, or the intensity of natural lighting in various sections of the United States, at different seasons of the year and hours of the day, and under various atmospheric conditions.

The shading effects of wire insect cages used to protect plants from insect pests are being studied, and the effect of the various kinds of shade cloth employed by tobacco growers to improve the quality of the tobacco leaf. Studies with shade cloths have been made to determine the relation between sunlight intensity and the development of certain plants.

Measurements are also being made of the heat radiated from different types of orchard heaters, and of the retardation of nocturnal cooling by a smoke cover. These studies find practical application in orchard protection against frosts.

Studies in Seismology. While the study of earthquakes is outside the field of meteorology, it bears a sufficiently close relation to be included among the activities of the Weather

Bureau. Observations in seismology were carried on incidentally by the Signal Corps without special legislative authority for a number of years. The agricultural appropriation act of June 30, 1914 (38 Stat. L., 415, 417) included a provision charging the Weather Bureau specifically with the conduct of this work, the bureau being the only government institution having field stations in operation at a sufficient number of well distributed points throughout the country, equipped with a suitable personnel for carrying on this work. Since that time, seismology has been annually included among the items for which appropriations have been made. The work of regularly collecting and publishing earthquake data began December 1, 1914. The data are of two kinds—noninstrumental reports of earthquakes felt, and instrumental records, often of quakes wholly imperceptible to the senses. The noninstrumental reports are rendered by all the regular stations and by nearly all the coöperative observers. The instrumental records published by the Weather Bureau have been obtained in part by instruments owned and operated by the bureau itself, one at Washington, and one at Northfield, Vermont, and partly through the coöperation of eighteen additional stations distributed from Panama to Alaska and from the Hawaiian Islands to Porto Rico.

By means of these observations and the studies based on them, it is expected that the Weather Bureau will gradually be able to find and to map those numerous breaks and weak vertical seams in the earth's crust along which abrupt slipping and sliding—the cause of nearly all earthquakes—most frequently occur, and thereby to reduce earthquake damage by advising the avoidance of all dangerous places in the location of dams, aqueducts, bridges, and other important structures.

Studies in Volcanology. This work was taken over by the Weather Bureau in compliance with a provision of the appropriation act of October 1, 1918 (40 Stat. L., 973, 975). The purpose of the appropriation was to enable the bureau to

conduct investigations in volcanology at Kilauea Volcano, on Hawaii Island, the plan being to extend the studies if possible to Alaska later on. Investigations had been conducted at Kilauea since 1912, first under the auspices of the Massachusetts Institute of Technology and since 1913 by the Hawaiian Volcano Research Association. The Weather Bureau took formal control of the work on February 15, 1919, retaining the services of the volcanologist who had until then been in charge of the investigations.

The program of the work contemplates little more than the maintenance of the systematic observations of the volcano, with some possible extensions in the way of a seismic survey of the vicinity of Kilauea. The work consists of lava measurements, keeping various seismometric records, and studying the volcanic gases, such as their composition and reactions, their effects on the rocks, their heat mechanism, and their radio activity. Some of the ultimate objects of this service are to ascertain the relation which volcanic output bears to air, water, earthquakes, etc., and whether volcanic energy may be available for the use of man. The work is mainly performed at the station on Hawaii Island.

Maintaining and Operating Telegraph Lines. There is a considerable number of stations at outlying points and on islands along the sea coasts and lake shores that cannot be reached by any telegraph and telephone lines operated by private companies. To establish the necessary communication with these stations it has been necessary since the beginning of the Weather Service to maintain government telephone and telegraph and cable lines.

The Weather Bureau owns and operates in whole or in part, the telegraphic, telephonic, and cable connections between Matunuck Beach and Block Island, Rhode Island; Norfolk, Virginia, Cape Hatteras, North Carolina; Sleeping Bear Point and North and South Manitou Islands, Michigan; Alpena, Middle Island, and Thunder Bay, Michigan; Grand Marais and White-

fish Point, Michigan; Charlevoix to St. James, Beaver Island, Michigan; Tatoosh Island and Port Angeles, Washington; North Head and Portland, Oregon; San Francisco and Point Reyes and Tamalpais, California. A cable connecting Key West and Sand Key, Florida, was formerly operated by the Weather Bureau, but it became unserviceable and a new one was laid during the World War by the Navy Department when that department took over the operation of the Sand Key station. The station has since been returned to the Weather Bureau which has unrestricted use of the cable.

These cables and wires are used for the transmission of weather reports, forecasts, and storm warnings and reporting the passage of vessels. Some of them are also used for private business, in which case a charge is made in the same way as on regular commercial lines.

Instrument Equipping and Testing. All instruments used by the Weather Bureau and its coöperative observers are tested and standardized by experts at the central office, who also supervise their installation, and the installation and maintenance of automatic river gages and the display equipment of storm warning stations. Attention is also given to the designing and constructing of new instrumental equipment.

Other Meteorological Work. In addition to the regular meteorological work above mentioned, special studies and investigations are undertaken from time to time either by utilizing the material on hand or by means of special observation and research. Among such activities in recent years are the following:

Evaporation Work. There are thirty-eight stations, well distributed over the country at which special evaporation observations are made and reported each month to the central office in Washington.

Atmospheric Moisture. Much material has been gathered

in preparation of a report on the vapor pressure and relative humidity of the United States.

Cyclones and Anticyclones of the United States. A study of the various types of cyclones and anticyclones of the United States and their average movements has been made and published.

Treatise on Weather Forecasting. A board consisting of four of the most experienced forecasters have been engaged upon the preparation of a treatise or manual on weather forecasting in the United States, which has been published. It deals with the general principles of the art of weather forecasting.

Mountain Snowfall. Snow surveys are being made to determine the depth and density of the snow cover at high altitudes in certain drainage basins of the west. Several hundred stations are being maintained in the elevated regions of the Far Western states, at which precise measurements are made of the depth and water contents of the snow which falls in the elevated portions of those states. These measurements are useful in determining approximately the amount of water available for irrigating purposes on the adjacent lowlands.

Climate of Africa. By request of other departments of the National government, and for the use of the Peace Conference at Paris, the Weather Bureau, after the armistice, prepared a general summary of the climate of Africa, with special attention to that of the former German colonies, consisting of charts showing graphically the annual and monthly distribution of precipitation and temperature over the continent, together with a discussion of its climatic characteristics.

Meteorological War Service. During the war the activities of the Weather Bureau were extended to two primary projects: (1) The forecasting of the weather for purely military operations; (2) the sounding of the upper air for the benefit of aviators, balloonists, and artillerists. For the purpose of carrying on this work, two of the experts of the Weather Bureau were commissioned majors in the Signal Officers' Re-

serve Corps. In coöperation with French and English meteorologists, these two officers and other experienced forecasters of the Weather Bureau temporarily on military duty formed a meteorological unit, which received nightly telegrams containing weather reports from the eastern districts of the United States and Canada, which, together with local observations on the surface and in balloons in western Europe, enabled them to make forecasts for military purposes, and to furnish other meteorological information needed for the most effective work with artillery, airplanes, poison gas, etc.

The war activities of the Weather Bureau have been summarized as follows:[1]

1. Furnishing forecasts and warnings
   a. To army cantonments and camps and naval bases
   b. To railroads in connection with handling and transportation of food and other supplies
2. Furnishing War and Navy Departments with meteorological instruments
3. Supplying meteorological data to the Surgeon General's Office for use in connection with studies of dietetics, camp sanitation, hygiene, and the like
4. Making aërological investigations to secure free-air data for aviation and artillery uses
5. Conducting special work with kites to test searchlights at night and as an aid to artillerists in detecting moving objects in the air
6. Coöperating with the Signal Corps in training balloonists and enlisted men in meteorological work
7. Reporting vessels entering and leaving Atlantic, Gulf, and Pacific coast ports
8. Transmitting naval and military business over its telegraph and cable lines
9. Assisting in the organization of gas and flame regiments
10. Transferring to the War Department for service in France, meteorological experts and forecasters

[1] Weather Bureau, Annual Report, 1918.

CHAPTER III

Organization

The Weather Bureau consists of an administrative and scientific organization in Washington, and observing and forecast stations throughout the country and in some of the West Indian Islands and Central America. On July 1, 1921 there were 213 stations with paid employees and about 4500 stations manned by volunteers and by persons on part-time service.

The establishment in Washington consists of the offices of the Chief and Assistant Chief, the office of the Chief Clerk, and sixteen divisions.

The functions of the Chief of the Weather Bureau are defined in Section 3 of the organic act of October 1, 1890. The Assistant Chief and the Chief Clerk, assist the Chief in the scientific work and in the business administration of the bureau.

Administrative and Scientific Divisions. The sixteen divisions are as follows: Stations and Accounts, Supplies, Printing, Telegraph, Library, Editorial, Forecasts, Forecasting, Climatological, Agricultural Meteorological, Marine, Aërological, River and Flood, Solar Radiation, Seismological, and Instrument.

Stations and Accounts Division. This division transacts all business relating to the finances of the bureau; audits, adjusts, and prepares for payment, all accounts and claims against the bureau; prepares advertisements; issues transportation requests, and supervises the construction and repair of Weather Bureau buildings outside of Washington. The per-

sonnel of the division consists of the Chief and Assistant Chief and twelve other employees.

Supplies Division. This division purchases and issues the supplies of the bureau, both in the Washington establishment and at the stations, and is charged with the safe-keeping of all property belonging to the bureau. The personnel consists of a Chief and an Assistant Chief and nine other employees.

Printing Division. This division prints and mails the daily weather map and the various charts and miscellaneous printed matter pertaining to the bureau, and has the custody of and distributes station forms. It consists of the office of the Chief of Division, a composing room, a press room, and a lithographing section. The personnel consists of the Chief of Division, a clerk, and a force of twenty-three skilled and unskilled workers.

Telegraph Division. This division receives, transmits, and records all telegrams from the central office, supervises the telegraph work performed at field stations, arranges telegraph circuits, maintains and repairs Weather Bureau telegraph lines and submarine cables, and examines all telegraph and field telephone accounts. The personnel consists of a Chief and Assistant Chief, ten operators, and two messengers.

Library. The library includes standard works of reference, technical books on meteorology and allied sciences, and a complete file of the publications of meteorological and climatological services in all parts of the world. It contains a catalogue, prepared in the library, of the meteorological contents of all the principal scientific periodicals of the world, including proceedings and transactions of societies. Translations from foreign languages, required in the bureau, are made in the library. The personnel consists of the Librarian, who ranks as a meteorologist, two clerks, and a messenger.

Editorial Division. This office has general editorial supervision over scientific and semi-scientific papers submitted for publication by the bureau, calling attention to such of these as seem appropriate for the *Monthly Weather Review,* for the

Journal of Agricultural Research, newspapers, etc.; it prepares summaries, indexes, abstracts, and notes concerning the progress of meteorological science; and it edits and supervises the publication of the *Monthly Weather Review.* The personnel consists of the Editor, who ranks as a meteorologist, an assistant, and a clerk.

Forecast Division. This division supervises the receiving and charting, twice daily, of telegraphic reports of the prevailing weather conditions, and distribution of information as to current weather conditions and forecasts of impending weather changes in all parts of the country; also warnings of storms, hurricanes, cold waves, frosts, heavy snows, etc., for the special benefit of agriculture, commerce, and navigation, including aviation. It checks up the verifications of the forecasts made by the district and local forecasters.

The division is subdivided into the office of the meteorologist in charge, the clerical section, map section, observatory, and verification section. The personnel consists of the Meteorologist in charge of the division, an assistant, two Meteorologists, an Observer, and twelve other employees.

Forecasting Division. This is the central office of the largest of the five principal districts into which the country is divided for forecast purposes. Being located at the headquarters of the Weather Bureau, it is not regarded as one of the stations, but as a part of the central office. The forecasts made in this division cover the entire eastern part of the United States east of the upper Mississippi Valley and of the lower Mississippi River. The chief of this division has supervisory control over the forecasts made in other districts. The personnel consists of a Meteorologist in charge, an assistant, and an Observer.

Climatological Division. This division has charge of the collection, study, and publication of climatological data for the United States. It has general supervision of the work of about 4500 coöperative stations and about thirty-five special meteorological stations, from which are collected by mail the

records of daily observations of temperature, precipitation, and other meteorological conditions necessary to establish the history of the climate of the various portions of the United States. It supervises the equipment and personnel of stations maintained in connection with the principal agricultural activities of the country. The division supervises the issue of a weekly bulletin during the winter months, showing the depth of snow on the ground and the thickness of ice in rivers and harbors; and from time to time it issues special bulletins or papers bearing on climatological subjects. It prepares the climatological portions of the annual reports of the bureau, and supervises the monthly and annual summaries and other publications of the climatological services of the various states. The division has charge of the barometry of the United States, and the preparation of the normals of pressure, temperature, precipitation, etc. The personnel of the division consists of a Climatologist in charge, an assistant, and sixteen other employees.

Division of Agricultural Meteorology. This division conducts studies concerning the relation of weather to crops, and collects statistical data required in such studies. It directs and supervises the coöperative relations of the Weather Bureau with the state experiment stations and other contributing organizations. The division supervises the work of about 400 special stations maintained in connection with the corn, wheat, cotton, sugar, rice, tobacco, fruit, and cattle industries, and supervises the distribution of special warnings for the benefit of growers. It collects and publishes data showing the current weather conditions throughout the country and the effects of these conditions upon important crops, and supervises the issue of weather crop summaries at the various state centers. The personnel of this division consists of a Meteorologist in charge, an assistant, and three other employees.

Marine Division. This division supervises the work of securing and collating reports from marine observers containing information pertaining to the ocean, prepares charts of the

meteorology of the ocean, and supplies the information concerning the paths of storms published by the Hydrographic Office of the Navy Department on its pilot charts. The personnel of the division consists of a Chief of Division, an assistant, and a clerk.

Aërological Investigations Division. The work of this division includes supervision over the making of observations at certain field stations by means of kites and balloons and the reduction, study, and publication of data thus obtained with the view of extending knowledge concerning the dynamics of the atmosphere and making useful and practical information available to artillery, aviation, and other interests. Data of the upper atmosphere are received in this division by telegraph from observing stations for use in diagnosing general weather conditions and for furnishing information on conditions in the free air for the use of aviators. Reports are received from six stations at which upper air observations are made by means of kites and balloons and from eight others where balloons only are used. The personnel of this division consists of a Meteorologist in charge, an assistant, and thirteen other employees.

Solar Radiation Investigations Division. Measurements are made in this division of the rate at which heat is received at the surface of the earth by radiation, during the day, from the sun and sky combined, and from each source separately, the heat lost at night, and the relation of these measurements to atmospheric conditions. The work of this division is done by a Meteorologist in charge and an assistant.

River and Flood Division. This division has charge of the collection of information as to stages of water along the navigable rivers, the issue of flood warnings, and the study of the physical characteristics of the rivers of the United States; information on the depth of snowfall in the mountains of the West for a study of the flow of water in the streams supplying irrigation projects; and information on the rate of evaporation from ponds and lakes in the interest of water

storage for irrigation, power development, and navigation; and it supervises, on the part of the Weather Bureau, the experiment stations maintained jointly by the Weather Bureau and the Forest Service. It has administrative control of the entire river and flood service of the bureau and has general supervision of the installation and unkeep of river gages, the collection and publication of statistical data, and the preparation of rules for flood forecasting. The geographic unit of the field service is the river district center, one to each watershed, except in the case of the largest rivers, where it becomes necessary on account of the size of the watershed to create a number of district centers, all of equal rank and each having a definite stretch of the river under its charge. The total number of river district centers is sixty-two. Daily gagings are made for some part of the year at 4688 stations.

The officer in charge of each district center is responsible to the central office for the administration and control of the subordinate gaging and rainfall reporting stations in his district, and for the issue and distribution of flood warnings when necessary. For navigable rivers, daily stages are published in the interest of navigation.

River district centers, almost without exception, are also full-reporting meteorological stations, and as such, distribute the usual routine information, such as warnings of unusual weather conditions, etc. The personnel of the division consists of a Meteorologist in charge, an assistant, and a clerk.

Seismological Investigations Division. The investigations made by this division includes the collection and study of both instrumental records and personal observations of earthquake phenomena throughout the United States. One of the immediate objects in view is the detailed mapping of the country with reference to existing faults on the lines of weakness of the earth's crust as evidenced by breaks or movements thereon that occasionally take place, causing small local earthquakes, such maps being of value to those who have occasion to locate dams and similar important permanent structures. The per-

sonnel of this division consists of a Professor of Meteorological Physics in charge, and an assistant.

Instrument Division. This division supervises the maintenance of a high standard of instrumentation and equipment for the meteorological and seismological observational work of the bureau. This involves the supervision of the installation and methods of use of the instruments and equipment required for meteorological observations in the field; the installation and maintenance of the display equipment of storm-warning stations; supervision of all evaporation work; installation and maintenance of automatic river gages; the adjustment and application of corrections of instruments in use by observers in the field; problems relating to protection from lightning; the testing, standardizing, and repairing of all apparatus; and the designing and constructing of new instrumental equipment. The division consists of the office of the Meteorologist in charge, a clerical section, a testing and designing section, and a machine shop. The personnel consists of a Meteorologist in charge, an assistant, two Meteorologists, six instrument makers, and five other employees.

Stations. The Weather Bureau maintained on July 1, 1921 throughout the United States, in the West Indies, in Alaska, and in Hawaii, 213 regular stations, employing on full time from one to fifteen persons each, and about 4500 other stations. Most of these perform the simple function of observing and reporting meteorological conditions, and when located on rivers, the stage of the river. Of the 213 stations, all but two repair stations take meteorological observations. Some of the stations are also district centers at which forecasts are made, and climatological data collected and published, and others are river and flood service centers, and centers for the receipt and distribution of other meteorological data.

The stations of the Weather Bureau are of four kinds: (1) Those manned by regular paid employees who devote their entire time to the service and who take such regular meteor-

ological observations and perform such other supervising or research work as may be required; (2) stations where persons are employed only on part time to do specific work, such as reading and reporting the river stage and rainfall; (3) cooperative stations for climatological, weather-crop, or weather-road service, and for distribution of forecasts and warnings, the work of which is performed by volunteers who receive no compensation for their services except copies of the publications of the bureau; and (4) repair and vessel reporting stations with full-time employees.

With regard to the carrying out of their particular functions, these stations are grouped as follows, the same station appearing in either one, several, or all of the groups as the case may be:

Forecast Districts:

For forecast purposes there are five principal districts. The Washington District for all the states east of the Upper Mississippi Valley and the Lower Mississippi River, with the central point at Washington; the Chicago District, for the Upper Mississippi Valley and the northwest, with the central point at Chicago; the New Orleans District, for Louisiana, Texas, Arkansas, and Oklahoma, with the central point at New Orleans; the Denver District, for Utah, Colorado, New Mexico, and Arizona, with the central point at Denver; and the San Francisco District, for California, Nevada, Washington, Oregon, and Idaho, with the central point at San Francisco. In addition to these, the meteorologist at Juneau, Alaska, occasionally makes forecasts for that territory and the meteorologist at San Juan, Porto Rico, for that island.

Climatological Districts:

Each state is arbitrarily made a climate unit for convenience in administration and for the collection and publication of climatological data, except that the New England states constitute one climatic group. Similarly, Maryland and Delaware, Porto Rico, and Hawaii, constitute each

a unit. There are forty-five units or districts. One principal station in each unit supervises the work of the district under the direction of a climatologist who has the title of Section Director. Reports are rendered monthly by mail.

Crop Reporting Districts:

Great agricultural sections of the country are grouped according to the staple crops cultivated therein, thus: Cotton region, corn and wheat region, sugar and rice region, tobacco region, etc. In some cases these regions overlap, and small regions are sometimes comprised wholly within greater regions. During the crop season these groups of stations report by telegraph to their appropriate section centers, and the reports are given wide dissemination.

River Districts:

Stations reporting river and flood information are grouped into districts chiefly by rivers and their immediately contiguous watersheds, each with a central station within the district. Several districts are engaged in handling the work for large rivers. Reports are made by mail or telegraph, as the work requires, to the central stations, and all are organized under, and supervised by a responsible director at the Washington office.

Hawaiian Volcano Observatory:

In addition to the stations included in the above groups, there is an observatory at Kilauea Volcano on Hawaii Island for taking volcanological observations, the results of which are published in a monthly bulletin issued at Honolulu. This station reports direct to the Chief of the Weather Bureau.

APPENDIX 1

OUTLINE OF ORGANIZATION

Explanatory Note

The Outlines of Organization have for their purpose to make known in detail the organization and personnel possessed by the several services of the national government to which they relate. They have been prepared in accordance with the plan followed by the President's Commission on Economy and Efficiency in the preparation of its outlines of the organization of the United States government.[1] They differ from those outlines, however, in that whereas the Commission's report showed only organization units, the presentation herein has been carried far enough to show the personnel embraced in each organization unit.

These outlines are of value not merely as an effective means of making known the organization of the several services. If kept revised to date by the services, they constitute exceedingly important tools of administration. They permit the directing personnel to see at a glance the organization and personnel at their disposition. They establish definitely the line of administrative authority and enable each employee to know his place in the system. They furnish the essential basis for making plans for determining costs by organization division and subdivision. They afford the data for a consideration of the problem of classifying and standardizing personnel and compensation. Collectively, they make it possible to determine the number and location of organization di-

[1] House Doc. 458, 62d. Congress, 2nd Session, 1912—2 vols.

visions of any particular kind, as, for example, laboratories, libraries, blue-print rooms, or any other kind of plant possessed by the national government, to what services they are attached and where they are located, or to determine what services are maintaining stations at any city or point in the United States. The Institute hopes that upon the completion of the present series, it will be able to prepare a complete classified statement of the technical and other facilities at the disposal of the government. The present monographs will then furnish the details regarding the organization, equipment, and work of the institution so listed and classified.

OUTLINE OF ORGANIZATION

WEATHER BUREAU

DEPARTMENT OF AGRICULTURE

August 19, 1921

Organization Units; Classes of Employees	*Number*	*Annual Salary Rate* [1]
1. Office of the Chief of Bureau		
Chief	1	$5,000
Secretary	1	1,800
Messenger	1	660
2. Office of the Assistant Chief of Bureau		
Assistant Chief	1	3,250
Assistant	1	1,800
Stenographer	1	1,200
3. Office of the Chief Clerk		
1. Office proper of the Chief Clerk		
Chief Clerk	1	2,500
Assistant	1	1,800
Stenographer	1	1,400
Clerk	1	1,600
	1	1,400
	4	1,200
Messenger	1	660
Electrician	1	1,200
Switchboard Operator	1	660
Gardener	1	1,000
2. Files Section		
Clerk in Charge	1	1,600
Clerk	1	1,600
3. Drafting and Photographing Section		
Clerk (Draftsman) in Charge	1	1,600
Clerk (Draftsman)	4	1,200
4. Heat, Light, and Power Plant		
Engineer	1	1,300
Assistant Engineer	1	1,260
Skilled Mechanic (Asst. Eng.)	1	1,000
Fireman	3	840
5. Carpenter Shop		
Carpenter in Charge	1	1,300

[1] Net, or without the temporary "bonus" or additional compensation of 60 per cent. on classes below $400, of $240 on classes of $400 to $2500, and of an amount necessary to make the total compensation $2740 on classes of $2500 to $2740. This is subject to minor exceptions in special cases.

Carpenter	1	1,200
General Mechanic	1	1,000
6. Paint Shop		
Painter in Charge	1	1,200
Painter	1	1,000
7. General Messenger and Labor Service		
Foreman of Messengers and Laborers	1	1,000
Messenger Boy	5	600
	5	480
Truck Driver (Skilled Mechanic)	2	1,000
Skilled Mechanic (Blacksmith)	1	1,000
Skilled Mechanic (Packer)	1	1,000
Laborer	3	720
	2	660
	1	600
Charwoman	1	360
	3	240
4. Stations and Accounts Division		
Chief of Division	1	2,750
Assistant	1	1,800
Stenographer	1	1,200
Clerk	2	1,600
	2	1,400
	4	1,200
	2	1,000
Messenger	1	600
5. Supplies Division		
Chief of Division	1	2,000
Assistant	1	1,800
Clerk	3	1,400
	2	1,200
Clerk in Charge of Store Room	1	1,200
Skilled Mechanic (Chief Packer)	1	1,200
Skilled Mechanic (Packer)	1	1,000
Laborer	1	660
6. Printing Division		
1. Office of Chief of Division		
Chief of Division	1	2,500
Clerk	1	1,200
Addressograph Operator	1	1,000
Mechanic	2	1,000
Laborer	1	720
	1	600
2. Composing Room		
Compositor in Charge	1	1,440
Compositor	6	1,350
3. Press Room		
Foreman of Printing	1	1,600
Pressman	1	1,200
Mechanic	1	1,000
Folder and Feeder	4	720
4. Lithographing Section		

Lithographer in Charge	1		1,500
Lithographer	3		1,200
7. Telegraph Division			
Chief of Division	1		2,000
Assistant	1		1,600
Operator	3		1,400
	7		1,200
Messenger	2		600
8. Library			
Librarian in Charge (Meteorologist)	1		2,520
Clerk	2		1,200
Messenger	1		600
9. Editorial Division			
Editor (Meteorologist)	1		3,960
Assistant	1		1,800
Clerk	1		1,400
10. Forecast Division			
1. Office of the Meteorologist in Charge			
Meteorologist in Charge	1		3,250
Assistant	1		1,800
Stenographer	1		1,400
2. Clerical Section			
Clerk	1		1,600
	1	(Part Time)	1,200
	1		1,000
3. Map Section			
Meteorologist in Charge	1		1,800
Observer	1		1,440
Clerk	1		1,400
	4		1,200
4. Observatory			
Meteorologist in Charge	1		1,620
Clerk	1		1,400
5. Verification Section			
Clerk in Charge	1		1,600
Clerk	1		1,400
11. Forecasting			
Meteorologist in Charge	1		4,500
Assistant	1		3,000
Observer	1		1,440
12. Climatological Division			
Climatologist and Chief of Division	1		2,520
Assistant	1		1,800
Stenographer	1		1,200
Clerk	2		1,600
	5		1,400
	6	(1 Part Time)	1,200
	2		1,000
13. Agricultural Meteorology			
Meteorologist in Charge	1		3,500
Assistant	1		2,040
Stenographer	1		1,400

Clerk	1	1,200
	1	1,000
14. Marine Division		
Chief of Division	1	2,000
Assistant	1	1,600
Clerk	1	1,200
15. Aerological Investigations		
Meteorologist in Charge	1	2,520
Assistant	1	1,620
Stenographer	1	1,200
Clerk	4	1,200
	2	1,000
Observer	1	1,440
	2	1,260
Assistant Observer	3	1,080
16. River and Flood Division		
Meteorologist in Charge	1	3,960
Assistant	1	1,400
Clerk	1	1,200
17. Solar Radiation Investigations		
Meteorologist in Charge	1	3,240
Assistant	1	1,400
18. Seismological Investigations		
Professor of Meteorological Physics, in Charge	1	3,500
Assistant	1	1,260
19. Instrument Division		
1. Office of the Meteorologist in Charge		
Meteorologist in Charge	1	2,520
Assistant	1	1,800
Stenographer	1	1,200
Laborer	1	720
2. Clerical Section		
Meteorologist	1	1,620
Clerk	1	1,400
Assistant Observer	1	1,080
3. Testing and Designing Section		
Meteorologist in Charge	1	2,040
Assistant	1	1,620
4. Machine Shop		
Supervising Instrument Maker in Charge	1	1,620
Instrument Maker	1	1,600
	1	1,440
	3	1,300
20. Stations		
Meteorologist	1	4,500
Volcanologist	1	3,960
Meteorologist.	2	3,600
	7	3,000
	13	2,520
	3	2,500

	13	2,280
	28	2,160
	4	2,040
	64	1,800
	67	1,620
Observer	105	1,440
	53	1,260
Assistant Observer	51	1,080
	54	900
Vessel Repairer	1	960
	1	720
Apprentice	2	840
	3	720
	8	600
	15	480
Printer	1	1,440
	20	1,300
	1	1,200
	6	1,080
Skilled Mechanic	2	1,000
Repairman	1	1,200
	8	1,000
Laborer	12	720
	4	600
Messenger	11	720
	16	600
Messenger Boy	2	600
	93	480

APPENDIX 2

CLASSIFICATION OF ACTIVITIES

Explanatory Note

The Classifications of Activities have for their purpose to list and classify in all practicable detail the specific activities engaged in by the several services of the national government. Such statements are of value from a number of standpoints. They furnish, in the first place, the most effective showing that can be made in brief compass of the character of the work performed by the service to which they relate. Secondly, they lay the basis for a system of accounting and reporting that will permit the showing of total expenditures classified according to activities. Finally, taken collectively, they make possible the preparation of a general or consolidated statement of the activities of the government as a whole. Such a statement will reveal in detail, not only what the government is doing, but the services in which the work is being performed. For example, one class of activities that would probably appear in such a classification is that of "scientific research." A subhead under this class would be "chemical research." Under this head would appear the specific lines of investigation under way and the services in which they were being prosecuted. It is hardly necessary to point out the value of such information in planning for future work and in considering the problem of the better distribution and coördination of the work of the government. The Institute contemplates attempting such a general listing and classification of the activities of the government upon the completion of the present series.

Classification of Activities

1. Administration
2. Weather reporting and forecasting and distributing weather maps and bulletins
3. Climatological work
4. Work in marine meteorology
5. Work in argricultural meteorology
6. Work in aërology
7. Reporting effects of weather on highways
8. Studies in meteorology
9. Reporting and forecasting river stages
10. Studies in solar radiation
11. Studies in seismology
12. Studies in volcanology
13. Maintaining and operating telegraph and telephone lines
14. Testing instruments and equipping stations.

APPENDIX 3

PUBLICATIONS

The U. S. Weather Bureau issues periodical and other publications, mainly for educational purposes.

Weather maps are published daily except Sunday at Washington, D. C., and at sixty-five stations throughout the country. These maps show weather conditions for the United States and forecasts for the districts in which they are published. A weather map, known as the "second edition" is published in Washington, D. C., every day in the year, and shows the weather conditions and forecasts for all parts of the country.

A *National Weather and Crop Bulletin* with charts, was issued weekly at Washington, D. C., during the growing season, prior to 1922 giving an account of the influence of the weather on crops and out-door operations, a synopsis of the actual weather during the week, and summaries of such information by states or sections. During the cold season, December to March, it was combined with a report of snow and ice conditions and published weekly under the title *National Weather and Crop and Snow and Ice Bulletin.* This information is now published in the *National Weather, Crops, and Markets,* issued by the Department of Agriculture.

A *Monthly Weather Review* is issued containing climatological data for Weather Bureau stations and contributions from the research staff of the bureau and special contributions in the various branches of meteorology. Supplements to the *Monthly Weather Review* are published from time to time, each supplement or series of supplements being devoted to some particular study or investigation.

Climatological Data, is published monthly in forty-two

separate sections, each section corresponding as a rule to a separate state. Each section is published at the central station of the geographical division to which it relates, and contains detailed climatological data from all regular Weather Bureau and coöperative stations in the geographical division.

A monthly bulletin of the Hawaiian Volcano Observatory is published at Honolulu, Hawaiian Islands.

A report entitled *River Gauge Stations on the Principal Rivers of the United States* is published each year and contains an account of the floods that occurred during the year, the daily river stages, a detailed statement of the organization of the river and flood service, a list of gaging stations, gage readings, a description of gages and bench marks, the length and drainage areas of rivers, flood stages, high and low water, zero elevations, and other river information.

The *Annual Report of the Chief of the Weather Bureau* is published in octavo and in quarto form, the octavo edition containing only the administrative report, and the quarto edition containing also a summary of meteorological data from Weather Bureau stations.

In addition to the periodical reports the bureau publishes a series of "Bulletins" at irregular intervals, some of which are numbered and others lettered, which contain the results of special studies and investigations in meteorology. "Circulars" are published occasionally, containing descriptions and instructions for the use of meteorological instruments, methods of obtaining and tabulating meteorological records, and other information for the guidance of observers and others in the regular service and for coöperative observers.

Charts are issued from time to time containing such information as normal annual precipitation, normal annual temperature, highest and lowest temperatures ever observed, mean relative humidity, frost data, length of crop-growing season, etc., also tables for making certain meteorological computations.

APPENDIX 4

LAWS

(A) Index to Laws

Creation	
Weather Bureau, Department of Agriculture	26 Stat. L., 653
Personnel	
Chief of the Weather Bureau	26 Stat. L., 653 30 Stat. L., 752 41 Stat. L., 1315, 1316
Other employees	26 Stat. L., 653 30 Stat. L., 752 41 Stat. L., 1315, 1316
Promotions	28 Stat. L., 264, 274,
Changes in personnel	28 Stat. L., 727, 736
Travel allowance	37 Stat. L., 828, 830
Functions	
Duties of Chief of Weather Bureau	26 Stat. L., 653
Meteorological information for Hydrographic Office of Navy Department	36 Stat. L., 468, 508
Collecting and disseminating meteorological climatological, and marine information, and investigations in meteorology, climatology, seismology, volcanology, evaporation, and aerology	41 Stat. L., 1315, 1317
Maintaining a printing office in Washington, D. C.	41 Stat. L., 1315, 1317
Publications	
Weather map	24 Stat. L., 256

Printing, binding, and distribution of documents	28 Stat. L., 601, 605, 612, 615, 622 30 Stat. L., 468
Weather signals on mail cars	29 Stat. L., 99, 108
Addressing, mailing, etc., of weather maps, weather reports, and cards permitted	37 Stat. L., 360, 414
Supplies	
Meteorological instruments for voluntary observers	26 Stat. L., 398
Furniture, fuel, instruments, and other supplies	41 Stat. L., 1315, 1316, 1317
Appropriations	
To be made with those of other bureaus of the Department of Agriculture	26 Stat. L., 654
For fiscal year ending June 30, 1922	41 Stat. L., 1315, 1316
Miscellaneous	
Destruction of old telegrams	31 Stat. L., 191, 204
Counterfeiting weather forecasts and interfering with weather maps, flags, etc.	33 Stat. L., 861, 864 35 Stat. L., 1088, 1100
Sale of surplus maps and publications	34 Stat. L., 1256, 1258

(B) Compilation of Laws[1]

1886—Act of August 4, 1886 (24 Stat. L., 256)—An Act Making appropriations to supply deficiencies in the appropriations for the fiscal year ending June thirti-

[1] From February 9, 1870, to July 1, 1891, the official meteorological work in the United States was carried on by the Signal Service, later known as the Signal Corps of the United States Army, under the following acts of Congress, which as far as they relate to meteorological work have been superseded by the act of October 1, 1890, creating the civilian Weather Bureau in the Department of Agriculture: Rev. Stat. 221., meteorological observations, storm signals; Rev. Stat. 222., signal stations, reports, etc.; Rev. Stat. 223., telegraph lines connecting signal stations.

eth, eighteen hundred and eighty-six, and for other purposes.

* * * *

To pay . . . for making plates and publishing weather maps . . . ; and hereafter none of such work shall be done except under specific appropriations therefor made in advance. . . .

1890—Act of August 30, 1890 (26 Stat. L., 371, 398)—An Act Making appropriations for sundry civil appropriations of the Government for the fiscal year ending June thirtieth, eighteen hundred and ninety-one, and for other purposes.

* * * *

. . . the Secretary of War [Agriculture] as he may think proper, may cause to be issued such meteorological instruments (not exceeding one set valued at fifteen dollars to any one county) to voluntary unpaid observers, in order to secure meteorological data from such observers, under regulations to be prescribed by the Secretary of War [Agriculture]. . . .

1890—Act of October 1, 1890 (26 Stat. L., 653)—An Act To increase the efficiency and reduce the expense of the Signal Corps of the Army, and to transfer the Weather Service to the Department of Agriculture.

[Sec. 1]. That the civilian duties now performed by the Signal Corps of the Army shall hereafter devolve upon a bureau to be known as the Weather Bureau, which, on and after July first, eighteen hundred and ninety-one, shall be established in and attached to the Department of Agriculture, and the Signal Corps of the Army shall remain a part of the Military Establishment under the direction of the Secretary of War, and all estimates for its support shall be included with other estimates for the support of the Military Establishment.

* * * *

Sec. 3. That the Chief of the Weather Bureau, under the direction of the Secretary of Agriculture, on and after July first, eighteen hundred and ninety-one, shall have charge of the forecasting of weather, the issue of storm warnings, the display of weather and flood signals for the benefit of agriculture, commerce, and navigation, the gauging and reporting of rivers, the maintenance and operation of sea-coast telegraph lines and the collection and transmission of marine intelligence for the benefit of commerce and navigation, the reporting of temperature and rainfall conditions for the cotton interests, the display of frost and cold-wave signals, the distribution

of meteorological information in the interests of agriculture and commerce, and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States, or as are essential for the proper execution of the forgoing duties.

SEC. 4. That the Weather Bureau shall hereafter consist of one Chief of Weather Bureau and such civilian employees as Congress may annually provide for and as may be necessary to properly perform the duties devolving on said bureau by law, and the chief of said bureau shall receive an annual compensation of four thousand five hundred dollars, [now five thousand dollars] and be appointed by the President, by and with the advice and consent of the Senate;...[1]

SEC. 5. That the enlisted force of the Signal Corps, excepting those hereinafter provided for, shall be honorably discharged from the Army on June Thirtieth, eighteen hundred and ninety-one, and such portion of this entire force, including civilian employees of the Signal Service as may be necessary for the proper performance of the duties of the Weather Bureau, shall, if they so elect, be transferred to the Department of Agriculture, and the compensation of the force so transferred shall continue as it shall be in the Signal Service on June thirtieth, eighteen hundred and ninety-one, until otherwise provided by law: *Provided,* That skilled observers serving in the Signal Service at said date shall be entitled to preference over other persons not in the Signal Service for appointment in the Weather Bureau to places for which they may be properly qualified until the expiration of the time for which they were last enlisted.

* * * *

SEC. 9. That on and after July first, eighteen hundred and ninety-one, the appropriations for the support of the . . . Weather Bureau shall be made with those of the other bureaus of the Department of Agriculture, and it shall be the duty of the Secretary of Agriculture to prepare future estimates for the Weather Bureau which shall be hereafter specially developed and extended in the interests of agriculture.

1894—Act of August 8, 1894 (28 Stat. L., 264, 273)—An Act Making appropriations for the Department of Agriculture for the fiscal year ending June thirtieth, eighteen hundred and ninety-five.

* * * *

. . . Weather Bureau, under the direction of the Secretary of Agriculture . . . and the Secretary is hereby authorized to make promotions in the service without prejudice to those transferred from the Signal Service of the War Department.

[1] That part of Section 4 permitting the detail of officers for duty in the Weather Bureau was repealed by the Joint Resolution of July 8, 1898 30 Stat. L., 752.

1895—Act of January 12, 1895 (28 Stat. L., 601, 605, 612, 613, 622)—An Act Providing for the public printing and binding and the distribution of public documents.

* * * *

SEC. 31. All printing offices in the Departments now in operation, or hereafter put in operation, by law, shall be considered a part of the Government Printing Office, and shall be under the control of the Public Printer, who shall furnish all presses, types, imposing stones, and necessary machinery and material for said offices from the general supplies of the Government Printing Office; and all paper and material of every kind used in the said offices for departmental work, except letter and note paper and envelopes, shall be supplied by the Public Printer; and all persons employed in said printing offices and binderies shall be appointed by the Public Printer, and be carried on his pay roll the same as employees in the main office, and shall be responsible to him: *Provided,* That the terms of this Act shall not apply to the office in the Weather Bureau, . . . but the Public Printer, with the approval of the Joint Committee on Printing, may abolish any of these excepted offices whenever in their judgment the economy of the public service would be thereby advanced.

All work done in the said offices shall be ordered on blanks prepared for that purpose by the Public Printer, which shall be numbered consecutively, and must be signed by some one designated by the head of the Department for which the work is to be done, who shall be held responsible for all work thus ordered, and who shall quarterly report to the head of the Department a classified statement of the work done and the cost thereof, which report shall be transmitted to the Public Printer in time for his annual report to Congress.

The Public Printer shall show in detail, in his annual report, the cost of operating each departmental office.

* * * *

SEC. 73. Extra copies of documents and reports shall be printed promptly when the same shall be ready for publication, and shall be bound in paper or cloth as directed by the Joint Committee on Printing, and shall be of the number following in addition to the usual number: . . .

Of the Annual Report of the Chief of the Weather Bureau, four thousand copies for the Senate, two thousand copies for the House, and one housand copies for the Bureau.

* * * *

Sec. 89. . . . The Secretary of Agriculture may print such number of copies of . . . reports and bulletins, containing not to exceed one hundred octavo pages, as he shall deem requisite; and this provision shall apply to maps, charts, bulletins, and minor reports of the Weather Bureau, which shall be printed in such numbers as the Secretary of Agriculture may deem for the best interest of the Government. . . .

1895—Act of March 2, 1895 (28 Stat. L., 727, 736)—An Act Making appropriations for the Department of Agriculture for the fiscal year ending June thirtieth, eighteen hundred and ninety-six.[1]

* * * *

Salaries of the Weather Bureau: To enable the Secretary of Agriculture to carry out the provisions of the act of October 1, 1890, transferring the Weather Bureau to the Department of Agriculture; . . . and the Secretary is hereby authorized to make such changes or assignment to duty in the personnel or detailed force of the Weather Bureau for limiting or reducing expenses as he may deem necessary. . . .

1896—Act of April 25, 1896 (29 Stat. L., 99, 108)—An Act Making appropriations for the Department of Agriculture for the fiscal year ending June thirtieth, eighteen hundred and ninety-six.[2]

* * * *

That the Secretary of Agriculture, in coöperation with the Postmaster General, may arrange a plan by which there shall be displayed on all cars and other conveyances used for transporting United States mail, suitable flags or other signals to indicate weather forecasts, cold-wave warnings, frost warnings, and so forth, to be furnished by the Chief of the Weather Bureau.

1900—Act of May 25, 1900 (31 Stat. L., 191, 204)—An Act Making appropriations for the Department of Agriculture for the fiscal year ending June thirtieth, nineteen hundred and one.

* * * *

That hereafter all telegrams pertaining to the business of the Weather Bureau may be destroyed after they are three years old and the accounts based thereon have been settled by the Treasury Department; and the present accumulation of these old telegrams may be destroyed.

1905—Act of March 3, 1905 (33 Stat. L., 861, 864)—An Act Making appropriations for the Department of Agriculture for the fiscal year ending June thirtieth, nineteen hundred and six.

[1] Similar provisions are contained in the agricultural appropriation acts for the four preceding fiscal years.

[2] Provisions also in agricultural appropriation acts for 1895 and 1896.

Any person who shall knowingly issue or publish any counterfeit weather forecasts or warnings of weather conditions, falsely representing such forecasts or warnings to have been issued or published by the Weather Bureau, or other branch of the Government service, or shall molest or interfere with any weather or storm flag or weather map or bulletin displayed or issued by the United States Weather Bureau, shall be deemed guilty of a misdemeanor, and on conviction thereof, for each offense, be fined in a sum not exceeding five hundred dollars, or be imprisoned not to exceed ninety days, or be both fined and imprisoned, in the discretion of the court.[1]

1907—Act of March 4, 1907 (34 Stat. L., 1256, 1258)—An Act Making appropriations for the Department of Agriculture for the fiscal year ending June thirtieth, nineteen hundred and eight.

* * * *

. . . hereafter the Secretary of Agriculture is authorized to sell any surplus maps or publications of the Weather Bureau, and the money received from such sales shall be deposited in the Treasury of the United States, section 227 Revised Statutes notwithstanding; . . .

1909—Act of March 4, 1909 (35 Stat. L., 1088, 1100)—An Act To codify, revise, and amend the penal laws of the United States."

* * * *

Sec. 61. Whoever shall knowingly issue or publish any counterfeit weather forecast or warning of weather conditions falsely representing such forecast or warning to have been issued or published by the Weather Bureau, United States Signal Service, or other branch of the Government service, shall be fined not more than five hundred dollars, or imprisoned not more than ninety days, or both.

1910—Act of June 17, 1910 (36 Stat. L., 468, 508)—An Act Making appropriations for the legislative, executive, and judicial expenses of the Government for the fiscal year ending June thirtieth, nineteen hundred and eleven, and for other purposes.

* * * *

Hereafter the pilot charts prepared in the hydrographic Office shall have conspicuously printed thereon the following: "Prepared from data furnished by the Hydrographic Office of the Navy Department and by the Weather Bureau of the Department of Ag-

[1] It is a matter of doubt whether such of these provisions as are not contained in the act of March 4, 1909, given below are still in force. U. S. Compiled Statutes 1901, Supplement 1911.

riculture, and published at the Hydrographic Office under the authority of the Secretary of the Navy," and all meteorological information received by the Weather Bureau of the Department of Agriculture necessary for and of the character of such information heretofore used in the preparation of the pilot charts shall continue to be furnished with all possible expedition to the Hydrographic Office for use in the preparation of said charts; and not more than two naval officers shall be detailed or employed in the Hydrographic Office.

1912—Act of August 23, 1912 (37 Stat. L., 360, 414)—An Act Making appropriations for the legislative, executive, and judicial expenses of the Government for the fiscal year ending June thirtieth, nineteen hundred and thirteen, and for other purposes.

* * * *

Sec. 8. That no money appropriated by this or any other act shall be used after the first day of October, 1912, for services in any executive department or other Government establishment at Washington, District of Columbia, in the work of addressing, wrapping, mailing, or otherwise dispatching any publication for public distribution, except maps, weather reports, and weather cards. . . .

1913—Act of March 4, 1913 (37 Stat. L., 828, 830)—An Act Making appropriations for the Department of Agriculture for the fiscal year ending June thirtieth, nineteen hundred and fourteen.

* * * *

Hereafter officials and employees of the Weather Bureau when transferred from one station to another for official duty, shall be allowed all traveling expenses authorized by existing laws applicable to said bureau, notwithstanding any changes in appointments that may be required by such transfers; . . .

1921—Act of March 3, 1921 (41 Stat. L., 1315, 1316)—An Act Making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1922.

* * * *

WEATHER BUREAU

Salaries, Weather Bureau: Chief of bureau, $5,000; assistant chief, $3,250; chief clerk, $2,500; chiefs of divisions—one of stations and accounts $2,750, one of printing $2,500, three at $2,000 each; clerks—eight of class four, twelve of class three, twenty-four of class two, forty-eight of class one, nine at $1,000 each; foreman of printing, $1,600; lithographers—one $1,500, three at $1,200 each;

pressman, $1,200; printers or compositors—two at $1,440 each, six at $1,350 each, twenty at $1,300 each, one $1,200, six at $1,080 each; four folders and feeders at $720 each; instrument makers—supervisor $1,620, one $1,440, three at $1,300 each, one $1,260; skilled mechanics—one $1,300, three at $1,200 each, thirteen at $1,000 each; engineer, $1,300; three firemen at $840 each; captain of the watch, $1,000; electrician, $1,200; repairmen—one $1,200, eight at $1,000 each; gardener, $1,000; messengers or laborers—twenty-eight at $720 each, six at $660 each, twenty-two at $600 each; messenger boys—eleven at $600 each, one hundred at $480 each, charwomen—One $360, three at $240 each; in all, $346,580.

General Expenses, Weather Bureau: For carrying into effect in the District of Columbia and elsewhere in the United States, in the West Indies, in the Panama Canal, the Caribbean Sea, and on adjacent coasts, in the Hawaiian Islands, in Bermuda, and in Alaska, the provisions of an Act approved October 1, 1890, so far as they relate to the weather service transferred thereby to the Department of Agriculture, for the employment of professors of meteorology, district forecasters, local forecasters, meteorologists, section directors, observers, apprentices, operators, skilled mechanics, instrument makers, foremen, assistant foremen, proof readers, compositors, pressmen, lithographers, folders and feeders, repairmen, station agents, messengers, messenger boys, laborers, special observers, displaymen, and other necessary employees; for fuel, gas, electricity, freight and express charges, furniture, stationary, ice, dry goods, twine, mats, oil, paints, glass, lumber, hardware, and washing towels; for advertising; for purchase, subsistence, and care of horses and vehicles, the purchase of repair of harness, for official purposes only; for instruments, shelters, apparatus, storm-warning towers and repairs thereto; for rent of offices; for repairs and improvements to existing buildings and care and preservation of grounds, including the construction of necessary outbuildings and sidewalks on public streets abutting Weather Bureau grounds; and the erection of temporary buildings for living quarters of observers; for official traveling expenses; for telephone rentals, and for telegraphing, telephoning, and cabling reports and messages, rates to be fixed by the Secretary of Agriculture by agreements with the companies performing the service; for the maintenance and repair of Weather Bureau telegraph, telephone, and cable lines; and for every other expenditure required for the establishment, equipment, and maintenance of meteorological offices and stations and for the issuing of weather forecasts and warnings of storms, cold waves, frosts, and heavy snows, the gauging and measuring of the flow of rivers and the issuing of river forecasts and warnings; for observations and reports relating to crops and for other necessary observations and reports, including coöperation with other bureaus of the Government and societies and institutions of learning for the dissemination of meteorological information, as follows:

For necessary expenses in the city of Washington incident to collecting and disseminating meteorological, climatological, and marine

information, and for investigations in meteorology, climatology, seismology, volcanology, evaporation, and aërology, $108,410;

For the maintenance of a printing office in the city of Washington for the printing of weather maps, bulletins, circulars, forms, and other publications, including the pay of additional employees, when necessary, $11,450: *Provided,* That no printing shall be done by the Weather Bureau that can be done at the Government Printing office without impairing the service of said bureau.

For necessary expenses outside of the city of Washington, incident to collecting and disseminating meteorological, climatological, and marine information, and for investigations in meteorology, climatology, seismology, volcanology, evaporation, and aërology, $1,300,110, including not to exceed $697,080 for salaries, $129,040 for special observations and reports, and $295,750 for telegraphing and telephoning;

For investigations, observations, and reports, forecasts, warnings, and advices for the protection of horticultural interests from frost damage, $9,000;

For official traveling expenses, $30,000;

For the maintenance of stations for observing, measuring, and investigating atmospheric phenomena, including salaries, travel, and other expenses in the city of Washington and elsewhere, $81,020;

In all, for general expenses, $1,539,990;

Total for Weather Bureau, $1,886,570.

APPENDIX 5

FINANCIAL STATEMENT

Explanatory Note

Statements showing appropriations, receipts, expenditures and other financial data for a series of years constitute the most effective single means of exhibiting the growth and development of a service. Due to the fact that Congress has adopted no uniform plan of appropriation for the several services and that the latter employ no uniform plan in respect to the recording and reporting of their receipts and expenditures, it is impossible to present data of this character according to any standard scheme of presentation. In the case of some services the administrative reports contain tables showing financial conditions and operations of the service in considerable detail; in others financial data are almost wholly lacking. Careful study has in all cases been made of such data as are available, and the effort has been made to present the results in such a form as will exhibit the financial operations of the services in the most effective way that circumstances permit.

The United States Weather Bureau receives annual appropriations from Congress for salaries and expenses and also benefits from the allotments of the Department of Agriculture for printing and binding. In the following statement the item "salaries" includes both the amounts appropriated for salaries of the Weather Bureau under the appropriation heading "salaries, Department of Agriculture," and the salaries included under the appropriation "general expenses, Weather Bureau." The item "printing and binding" shows only the amounts allotted to the Weather Bureau from the appropria-

tion of the Government Printing Office. It does not include the amounts specified for "the maintenance of a printing office in the city of Washington," provided for in appropriation acts under "general expenses, Weather Bureau." These amounts are included under the latter heading.

Appropriations include all deficiency amounts but do not include "auditors certified claims." These are generally small, and in most cases their inclusion would result in duplication. The expenditures, with the exception of 1920 and 1921, are figured on the accrual basis; they include, therefore, the total amount expended out of each appropriation during the three years of its avalability. The figures for 1920 and 1921 show the estimated total expenditure for those years.

THE WEATHER BUREAU

APPROPRIATIONS AND EXPENDITURES: FISCAL YEAR 1892; BY FIVE-YEAR INTERVALS FROM 1895 TO 1910; AND ANNUALLY FROM 1910 TO 1922, INCLUSIVE.

Fiscal year ending June 30	Salaries [a]		Increase of Compensation [b]		General Expenses [c]		Printing and Binding by Govt. Printing Office		Total	
	Appropriation	Expenditure	Appropriation	Expenditure	Appropriation	Expenditure	Appropriation	Expenditure	Appropriation	Expenditure
1892	$ 506,230.00	$ 496,423.73			$ 373,523.50	$ 328,346.47	$ 10,000.00	$ 10,000.00	$ 889,753.50	$ 834,770.20
1895	511,485.00	487,818.31			365,338.06	335,441.87	10,000.00	10,000.00	886,823.06	833,260.18
1900	535,515.00	534,816.15			486,967.00	481,007.92	10,000.00	10,000.00	1,032,482.00	1,025,824.07
1905	672,740.00	672,112.52			665,000.00	664,086.06	25,000.00	24,816.33	1,362,740.00	1,361,014.91
1910	826,060.00	821,743.56			682,200.00	675,739.71	25,000.00	23,610.02	1,533,260.00	1,521,093.29
1911	826,550.00	825,207.75			698,210.00	669,604.65	45,000.00	44,944.34	1,569,760.00	1,539,756.74
1912	859,750.00	855,568.92			740,500.00	715,248.48	47,000.00	46,971.02	1,647,250.00	1,617,788.42
1913	884,930.00	880,112.82			734,750.00	712,091.42	47,000.00	46,674.68	1,666,680.00	1,638,878.92
1914	916,360.00	905,641.63			791,250.00	748,219.24	47,000.00	44,593.77	1,754,610.00	1,698,454.64
1015	918,270.00	907,453.54			749,000.00	730,696.44	[e] 47,000.00	29,989.21	1,714,270.00	1,668,139.19
1916	932,560.00	928,400.34			733,490.00	728,973.62	47,000.00	34,994.91	1,713,050.00	1,692,368.87
1917	962,780.00	952,368.81			784,480.00	766,748.73	47,000.00	34,998.76	1,794,260.00	1,754,116.30
1918	990,400.00	967,384.84	$ 54,875.19	$ 54,875.19	[d] 892,740.00	887,836.68	47,000.00	37,997.39	1,985,015.19	1,948,094.10
1919	1,001,450.00	973,267.26	81,882.03	81,882.03	911,480.00	834,236.27	74,000.00	39,983.08	2,041,812.03	1,929,368.64
1920 [f]	1,015,390.00	997,686.13	174,199.32	174,199.32	864,820.00	859,422.98	47,000.00	38,746.70	2,101,409.32	2,070,055.13
1921 [f]	1,044,450.00	1,033,450.74	206,120.52	206,120.52	832,100.00	823,570.76	47,000.00	41,999.74	2,129,670.52	2,105,141.76
1922	1,043,660.00				842,910.00		47,000.00		1,933,570.00	

[a] Including salaries of station officers and employees, included under general expenses in appropriation acts.
[b] Temporary indefinite appropriation based on the amount necessary to pay the bonus.
[c] Not including salaries of station officers and employees, and including contingent expenses.
[d] Of this amount, $100,000.00 was carried in the army appropriation act to be expended by the Weather Bureau for army aerological stations.
[e] Since 1915 this appropriation is "not to exceed" $47,000.00.
[f] 1920 and 1921 expenditures show estimated total expenditures.

APPENDIX 6

BIBLIOGRAPHY

Explanatory Note

The bibliographies appended to the several monographs aim to list only those works which deal directly with the services to which they relate, their history, activities, organization, methods of business, problems, etc. They are intended primarily to meet the needs of those persons who desire to make a further study of the services from an administrative standpoint. They thus do not include the titles of publications of the services themselves, except in so far as they treat of the services, their work and problems. Nor do they include books or articles dealing merely with technical features other than administrative of the work of the services. In a few cases explanatory notes have been appended where it was thought they would aid in making known the character or value of the publication to which they relate.

After the completion of the series the bibliographies may be assembled and separately published as a bibliography of the Administrative Branch of the National Government.

The Weather Bureau

Books and Pamphlets

American association of state weather services. Report of the first, [third-fourth] annual meeting of the American association of state weather services, coöperating with the Weather Bureau, U. S. Department of Agriculture. Washington, 1893–96. 3, v. (U. S. Weather Bureau, Bulletin no. 7, 14, 18)

Report of the second annual meeting, in 1893, was not published separately. An account of it was published in Monthly weather review, v. 21, p. 228-32.

Bigelow, F. H. Work of the meteorologist for the benefit of agriculture. (*In* U. S. Dept. of agriculture. Yearbook, 1899. Washington, 1900, p. 71-92).

Binckley, George S. and Lee, Charles H. Suggested changes and extension of the United States Weather bureau service in California. (*In* American society of civil engineers. Proceedings, Feb. 1915, v. 41 : 251-258)

Discussion of this article by Frank H. Tibbetts was published in the Proceedings, March, 1916, v. 42, p. 379–382.

Convention of Weather bureau officials. 1st, Omaha, Neb., 1898. Proceedings . . . Washington, Govt. print. off., 1899. 184 p. (U. S. Weather bureau, Bulletin no. 24)

—— 2d, Milwaukee, Wis., 1901. Proceedings . . . Washington, Govt. print. off., 1902. 246 p. (U. S. Weather bureau, Bulletin, no. 31)

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INDEX

Abbe, Cleveland, meteorological work of, 3, 4.
Academy of Science, Chicago, 3.
Aërological Investigations Division, 42, 52.
Aërological observations, 14, 29, 30, 37, 42.
Aërology, work in, 14, 29, 30, 37, 42.
Africa, climate of, 36.
Agricultural meteorology; Division of, 41, 51; work in, 27, 28, 41.
Agriculture, Department of, transfer of meteorological work to, 5, 6.
Alfalfa region reports, 27.
Anticyclones, 36.
Assistant Chief of Bureau, Office of, 38, 49.
Atmospheric moisture, 35, 36.
Automobilists, information for, 30.
Aviators, forecasts and information for, 21, 29, 30, 42.

Balloon observations, 14, 29, 42.
Bureau of Equipment, Navy Department, transfer of wireless apparatus to, 11.
Bulletin of International Simultaneous Observations, 13.
Bulletin of the Hawaiian Volcano Observatory, 57.

Cable lines, maintenance and operation of, 37.
Canada, Dominion of, coöperation with, 13, 37.
Cattle ranges, effects of weather on, 28.
Cattle region, reports, 27.
Central America, storm reports from, 23.
Chief Clerk, office of, 38, 49.
Chief of Bureau, office of, 38, 49.
Chief of Engineers, U. S. Army, meteorological records of, 14.
Chief Signal Officer, U. S. Army, 3, 4, 5, 10.
Cipher, telegraphic, 18.
Climatological districts, 45, 46.
Climatological Division, 40–41, 51.
Climatological work, 6, 7, 14, 15, 24–26, 41, 56, 57.
Coding system, telegraphic, 18.
Coffin, meteorological work of, 2.
Cold-wave warnings, 10, 22, 23, 28, 40.
Commerce and Labor, Department of, 11.
Commissioner General of the Land Office, meteorological work of, 2.
Coöperation, International, 13.
Coöperation with English and French meteorologists in war service, 37.
Coöperative observers, 25, 26, 28, 30, 38, 40-41, 45.
Coöperative stations, 25, 26.
Corn crop, effects of weather on, 28.
Corn and wheat region reports, 27.

Cotton crop, effects of weather on, 28.
Cotton region reports, 27.
Crop reporting districts, 46.
Crops, effects of weather on, 28, 41.
Cyclones, 36.

Duke of Tuscany, 1.

Earthquakes. See Seismology.
Editorial Division, 39, 51.
Emigrants, information for, 26.
Employees, number of, 47-53.
Engineer Corps, U. S. Army, meterological work of, 2.
Espy, James Pollard, meteorological work of, 2.
Evaporation work, 35, 40.
Evidence in courts, weather records as, 26.

Farmers, forecasts and information for, 6, 24, 26, 27–29, 30, 41.
Fire-weather warnings, 24.
Flags, cold wave, 10, 23, 24; storm, 23; temperature and weather, 10, 20.
Flood warnings, 10, 30–32, 42.
Forecast districts, 45.
Forecast Division, 40, 51.
Forecaster, Supervising, 20.
Forecasting, by wireless, 10, 21; method of, 17–20; treatise on, 36.
Forecasting Division, 40, 51.
Forecasts, river-stage, 30–32.
Forecasts, weather aërial, twice daily, for aeroplane services, 21; checking up, 22; district, 8, 19, 22; early—before Federal weather service, 2–4; for farmers, 24, 28; local, daily, 8, 21, 22; publication and distribution of, 7, 8, 20, 23; shippers, local, 22 special, 9; twice daily, 19-21; utilization of, 6, 20-24, 29; weekly, 10, 22; wireless, for vessels at sea, 21.
Forest Service, coöperation with, 24, 43.
Fort Myer, Va., school of instruction, 5.
Frost warnings, 23, 24, 28, 40.
Fruit growers, warnings and information for, 23, 24, 28, 40.
Fruit region reports, 28.

General Land Office, meteorological work of, 2.
Great Plains, cultivation and rainfall in the, 28.
Hail, occurrence and distribution of, 26.

Hawaiian Volcano observatory, 46, 57.
Hawaiian Volcano Research Association, 34.
Henry, Joseph, meteorological work of, 2, 3.
Highways, effects of weather on, 30.
Hurricanes, warnings of, 23, 40.
Hydrographic office, Navy Department, 11, 12, 27, 42.

Ice bulletin, 56.
Indications. See Forecasts, weather.
Industry, benefit of weather service to, 6, 26.
Insect pests, time for spraying operations for, 24.
Inspection of coöperative stations, 26.
Instrument Division, 44, 52.
Instruments, equipping, testing, and standardizing of, 4, 35, 44.

Instruments, meteorological, furnished to: coöperative observers, 25; Navy Department, 37; War Department, 37.
Interdepartmental Committee on Wireless Telegraphy and Meteorological work, 11.
International Congress of Meteorologists, 13.
International coöperation, 13.
International weather observations, 13.
Iowa State Weather Service, 9.

Journal of Agricultural Research, 40.

Kilauea, volcano, 34.
Kites, observations by, 29, 42.

Lanterns, storm, 23.
Lapham, I. A., 3.
Library, 39, 51.
Loomis, Elias, 2.

Marine Division, 41, 42, 52.
Marine meteorogical work, 10–12, 26, 27.
Massachusetts Institute of Technology, 34.
Maury, Matthew Fontaine, meteorological work of, 2.
Meigs, Josiah, meteorological work of, 2.
Merchants, benefits of weather service to, 6.
Meteorological observations. See Observations, meteorological.
Meteorological instruction, 5.
Meteorological records, concentration of, 14; evidence in courts, 26.
Meteorological research, 4, 6.
Meteorological Society of the Palatinate, 2.
Meteorological studies, 14, 35, 36.
Meteorological war services, 14, 36, 37.
Meteorological work: by civilians, 4; by commissioned officers, 4, 5; by enlisted men, 4, 5; before the creation of the Federal service, 1–3; by the Federal Government, development of, 6.
Meteorologists, congress of, 13.
Meteorology, dynamic, 29, 42.
Missouri Weather Service, 9.
Mitchell Astronomical Observatory, Cincinnati, 3.
Monthly Weather Review, 14, 15, 26, 27, 39–40, 56.
Mountain snowfall, 36, 42.
Myer, Albert J., Chief Signal Officer, 3.

National Weather and Crop and Snow and Ice Bulletin, 56.
National Weather and Crop Bulletin, 28, 56.
National Weather, Crops and Markets, 56.
Navigation, benefit of weather service to, 6, 23, 27.
Navy Department, 10, 11, 12, 21, 27, 37.
New York State, early meteorological observations in, 2.
North Atlantic and North Pacific Oceans, summaries of weather conditions over, 27.
Northern Hemisphere, weather map of, 10, 13.

Observations, meteorological; aerological, 14, 29, 37, 42; by balloons, 14, 29; by kites, 14, 29; climatological, 9, 24, 25; early, before Federal weather service, 1, 2; first, by Federal weather service, 4, 7; for forecast purposes, 7, 8, 16, 17; international, 13; nature of, 7, 8,

17; on mountains, 14; publication of, 8; purpose of, 16, 17; records, concentration of, 14; records as evidence in courts, 26; utilization of, 6, 16, 17, 26.
Observations, river, 10, 17, 30–32, 42, 43, 46.
Observers, coöperative voluntary, 25, 26, 28, 30, 38, 40, 41, 45.

Paine, H. E., member of Congress, 3.
Patent Office, meteorological work of, 2.
Pennsylvania, early meteorological observations in, 2.
Physician's, use of weather service to, 26.
Pilot charts, data for, 27.
Post Office Department, 20, 21.
President's Commission on Economy and Efficiency, 47.
Printing Division, 39, 50, 51.
Probabilities. See Forecasts, weather.
Publications, 14, 15, 56, 57.

Radio telegraphy, utilization of, 17, 18, 20, 21.
Railroads, utilization of meteorological records by, 26.
Redfield, William C., meteorological work of, 2.
Report, annual, of operations, 57.
Rice region, reports, 27.
River and Flood Division, 42, 43, 52.
River and flood service, 10, 17, 30–32, 42, 43, 46.
River districts, 46.
River Gage Stations on principal rivers of the U. S., 57.
River observations, 10, 17, 30–32, 42, 43, 46.
River stages, reporting and forecasting, 30–32, 42.

Salaries, 47–53.
School of instruction, Fort Myer, Va., 5.
Seismological Investigations Division, 43, 44, 52.
Seismology, studies in, 14, 32, 33.
Shippers, benefit of weather service to, 6, 23, 27.
Signal Corps, U. S. Army, cooperation with during world war, 37; weather service in, 1, 5.
Signals, cold wave, 10.
Signal Service, U. S. Army, original organization of weather service in, 1, 3, 4.
Signals, storm and wind, 2, 4, 6, 9.
Smithsonian Institution, meteorological work of, 2, 14.
Snowfall, mountain, 36, 42.
Snows, heavy, warnings of, 23, 40.
Solar Radiation Investigations Division, 42, 52.
Solar radiation, studies in, 14, 32.
State weather services, 9.
Stations and Accounts Division, 38, 50, 51.
Stations, Weather Bureau, 44, 45, 52, 53.
Storm and wind signals, 2, 4, 9, 23.
Storm flags, 23.
Storm lanterns, 23.
Storms, warnings of, 23.
Storms, West Indian, 13.
Sugar region reports, 27.
Supplies Division, 39, 50.
Surgeon-General, U. S. Army, meteorological work of, 2, 14.
Surgeon-General's Office, U. S.

Army, meteorological data supplied to, 37.

Telegraphic Division, 39, 51.
Telegraphic circuit system, 18, 19.
Telegraphic lines, maintenance and operation of, 34, 35, 39.
Tobacco region reports, 27.
Tornadoes, damage done by, 26.
Transportation, benefit of weather service to, 6, 23, 27.
Truck region reports, 27.

Vessel reporting, 37.
Volcano Observatory, Hawaiian, 46.
Volcanology, studies in, 14, 33, 34, 46.

War Department, 11, 21, 37.
Warnings of; cold waves, 10, 22, 23, 28, 40; fire-weather, 24; floods, 10, 31, 32, 42; frosts, 23, 24, 28, 40; heavy snows, 23, 40, hurricanes, 23, 40; storms, 4, 6, 7, 13, 23, 40. See also Forecasts, weather.
War service, meteorological 14, 36, 37.
Weather Bulletin, 20.
Weather cards, 20.
Weather charts, synoptic, 8, 18.
Weather Crop Bulletin, monthly, 9.
Weather, crops, and markets, 28.
Weather flags, 20.
Weather forecasting. See Forecasting, weather.
Weather forecasts. See Forecasts, weather.
Weather map of Northern Hemisphere, 13.
Weather maps, 20, 56.
Weather observations. See Observations, meteorological.
Weather records, evidence in courts, 26.
Weather reporting, method of, 17, 40.
Western Union Telegraph Co., 3.
West Indian storms, 13.
Wheat region reports, 27.
Wheat, winter, effect of weather on, 28.
Wireless stations of the Navy Department, utilization of, 12.
Wireless telegraph, transfer to Navy Department, 11.

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